METALLURGICAL ENGINEERING DEPARTMENT

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GENERAL STATEMENT

Dr. R.W. Smith and Dr. M.R. Viner of the Department of Metallurgical Engineering of Queen's University at Kingston, Ontario have been collaborating with Mr. R.K. Buhr, Dr. R.D. Warda, Dr. K.G. Davis, and Dr. L.V. Whiting of PMRL, CANMET, in the development of a user-friendly casting programme. This is concerned mainly with the risering of steel castings, but includes a description of gating sufficient to permit accurate calculations of casting weight and yield, and also of costs. The latter includes the optional use of riser sleeves, topping and cleaning costs.

The programme permits the user to calculate the modulus of casting sections, making use of high resolution graphics to describe the casting sub-sections but, as delivered, does not receive input from a graphics tablet. Feeding distances are calculated for rectangular sections for situations involving no chills, chills and padding. The riser size is then calculated following the method described by Ruddle and involving the thermal properties of the surroundings of the riser.

In carrying out the development of the programme, in most cases, it was necessary to inspect the original foundry science publications. Frequently, it was found that the summaries appearing elsewhere misquoted the earlier results. Also, it was found that there were many gaps in the available data.

There follows a series of sections which more fully describe various aspects of the programme which is now being tested on foundry science students.

CANMET RISERING PROGRAMME

PROPERTIES AND LIMITATIONS

PURPOSE:

- To assist the foundry engineer in rapid estimation of optimum riser requirements and cost analysis for low-carbon steel castings.

ADVANTAGES:

- No computer experience necessary. Interactive features minimize input errors, facilitate error corrections, and allow the operator to repeat calculations without re-entry of data.
- Allows a variety of molding materials and processes.
- Up-to-date information on feeding distances and gating system design.
- Accurate costing, including sleeve and cleaning costs. Summarizes costs for the entire casting.
- Increased productivity through the ability to examine several configurations quickly to obtain the optimum casting design.
- Unprotected software - may be altered or customized by the user as desired.

LIMITATIONS:

- Allows only 10 sub-sections to be fed by a given riser.
- Will only sum 10 risered sections for net cost analysis and gating design.
- Printer output for cost analysis is limited to what appears on the screen.
- Complex shapes and cross sections cannot be entered as part of the casting size/shape description.

  Most of these limitations are expected to be removed in the next release of the software.

MINIMUM SYSTEM REQUIREMENTS:

- Apple IIe with 1 disk drive
- Apple II+ with 48K RAM, 1 disk drive, DOS 3.3
- Apple II with 64K RAM and Applesoft, 1 disk drive, DOS 3.3

CANMET RISERING PROGRAMME
PROGRAMME VARIABLES

Most variables with a single character name are re-definable - i.e. they may be used to represent different things in different parts of the program.

The CUSTOMER/CASTING INFO variables stored on disk at the user's option are:

UN$ - user name (up to 107 characters)
CN$ - customer name (up to 103 characters)
CA$ - customer address (up to 100 characters)
CC$ - customer city/province (up to 98 characters)
PO$ - purchase order code (up to 60 characters, the first 20 of which are used as part of disk file names)
DT$ - date of analysis (up to 64 characters)
CD$ - casting description (up to 137 characters)
U$ - units (<I>mperial or <M>etric)
MM$ - moulding material (pre-defined names)
PC - per cent carbon in steel
DF - density of steel
TD - density of THERMIT, the assumed hot topping
SH - per cent shrinkage of steel (function of PC and PT)
PT - pouring temperature of steel
FF - feeding factor for moulding material
MW - mould wall movement allowance for moulding material
GS - gate/sprue area ratio for gating system
HS - height of sprue in gating system
HC - height of pattern in cope
HD - depth of pattern in drag
NG - number of gates
NA - number of gates attached to casting

The SECTION/RISER DATA variables stored on disk at the user's option are:

VC - volume of casting section
SC - effective surface area of casting section
AC - area of chills on casting section
CN - number of chills on the casting section
RT - riser type parameter (values 1 through 7)
RH - riser height for the casting section
RD - riser diameter for the casting section
TW - weight of hot topping for the riser
CS - cost of insulating sleeve (if any) per unit length
TI - thickness of top insulation (if any)
YD% - section yield of optimum design riser
ND - neck diameter for knock-off core
NL - neck length for knock-off core
NR - number of identical sections with identical risers
VC()- volume of sub-section (10 values per risered section)
SC()- effective surface area of sub-section
AC()- area of chills on sub-section
CN()- number of chills on sub-section

The COST ANALYSIS variables stored on disk at the user's option are:

CM - cost of metal per unit weight
CR - credit for scrap metal per unit weight
CT - cost of hot topping per unit weight
CI - cost of top insulation per unit weight
CC - cost of riser and gate cutoff loss per unit area
CH - cost of removing chills per unit area
CP - cost of removing padding per unit volume

Additional casting variables not stored on disk:

FL - fluidity of the steel (function of PT)
VN - net volume summed over casting sections
SN - net surface area summed over casting sections
NC - net chill area summed over casting sections
TC - total number of chills on the casting
RV - net riser volume summed over casting sections
NV - net neck volume summed over casting sections
AN - net area of chills on casting
CA - cost of sleeve insulation per unit area
WT - total weight of hot topping on all risers
DI - density of any top insulation used
WI - weight of top insulation for a given riser
IW - total weight of top insulation on all risers
IC - net cost of all top insulation
SL - net length of sleeves for all risers
SP - net price of sleeves summed over risers
MC - maximum sub-section modulus
VG - volume of gating system
GA - net area of gates
AG - area of connection between gates and casting
TP - pouring time for metal into gating system

Variables with a single character name which are not re-definable are:

B$ - "beep" character, to warn user of improper input
C$ - "comma" character, for writing to disk files
D$ - "carriage return" + "CTRL-D" character, for disk operating system commands from within the program
M$()- array of riser types for RISER SIZE/SHAPE option
P$ - printer status: tells user whether sotware toggle will turn printer on or off
S$ - single space character, used for screen print formatting
U$ - indicates whether <I>mperial or <M>etric units are used
X$ - contains 10 spaces, used for formatting numbers via string manipulation
N - sub-section number
P - flag to determine whether header has been printed out for feeding distance table
P% - slot number for printer

```
                          +--------------------------+
 10                       ! ************************ !
 15                       ! *                      * !
 20                       ! *    CANMET RISERING   * !
 25                       ! *                      * !
 30                       ! *     HELLO PROGRAM    * !
 35                       ! *                      * !
 40                       ! *    BY: M.R. VINER    * !
 45                       ! *    21 MARCH  1983    * !
 50                       ! *                      * !
 55                       ! ************************ !
                          +--------------------------+
100 PI = 3.14159:
    B$ = CHR$(7):
    C$ = ",":
    D$ = CHR$(13) + CHR$(4):
    S$ = " ":
    X$ = "          ":
    P$ = " ON"
                               +-----------------+
200                            !  DEFAULT VALUES !
                               +-----------------+
300 P% = 1:                           !  PRINTER SLOT NUMBER
400 :

500 MM$ = " GREEN SILICA SAND ":      !  MOLDING MATERIAL
600 SH = 5:                           !  % SHRINKAGE FOR MM$
700 FF = 1:                           !  FEEDING FACTOR FOR MM$
800 MW = 3:                           !  MOLD WALL MOVEMENT (%) FOR MM$
900 :

1000 PT = 2912:                       !  POURING TEMPERATURE (F)
1100 DF = .283:                       !  DENSITY OF STEEL (LB/CU.IN)
1200 TD = .071:                       !  DENSITY OF HOT TOPPING (LB/CU.IN)
1300 DI = .001:                       !  DENSITY OF TOP INSULATION (LB/CU.IN)
1400 :

1500 GS = 2:                          !  GATE/SPRUE AREA RATIO
1600 :

1700 :

1800 U$ = "I":                        !  IMPERIAL UNITS:

1900 :

2000 U1$ = "IN":                      !  LENGTH
2100 U2$ = "LB":                      !  WEIGHT
2200 U3$ = "SQ.IN":                   !  AREA
2300 U4$ = "CU.IN":                   !  VOLUME
2400 U5$ = "F":                       !  TEMPERATURE
2500 U6$ = "LB/CU.IN":                !  DENSITY
```

```
                          +-----------------------------+
2600                      !  DESCRIPTION OF RISER TYPES !
                          +-----------------------------+
2700 M$(1) = " SLEEVE WITH HOT TOPPING ":
     M$(2) = " SLEEVE WITH INSULATED TOP ":
     M$(3) = " SLEEVED BLIND RISER ":
     M$(4) = " SLEEVE WITH OPEN TOP "
2800 M$(5) = " SAND RISER WITH HOT TOPPING ":
     M$(6) = " BLIND SAND RISER ":
     M$(7) = " SAND RISER WITH OPEN TOP ":
     M$(8) = "CAUTION: TOP OF RISER WILL FREEZE EARLY,     POSSIBLY CAUSING PRES
     SURE PROBLEMS."
                          +-----------------------------+
2900                      !  SET UP GRAPHICS PARAMETERS !
3000                      !  AND ERROR HANDLER ROUTINE  !
                          +-----------------------------+
3100 POKE  - 16301,0:
     POKE 232,0:
     POKE 233,64:
     SCALE= 1:
     HCOLOR= 3
3200 FOR I = 768 TO 777:
        READ B:
        POKE I,B:
     NEXT
3300 DATA  104,168,104,166,223,154,72,152,72,96
                               +---------------------+
3400                           !  TITLE & DISCLAIMER !
                               +---------------------+
3500 HOME :
     VTAB 2:
     INVERSE :
     PRINT SPC( 40):
     PRINT "         CANMET RISERING PROGRAM        ";:
     PRINT SPC( 40):
     PRINT "  DESIGNED BY QUEEN'S UNIVERSITY STAFF  ";
3600 PRINT "    IN COLLABORATION WITH PMRL/OTTAWA   ";:
     PRINT SPC( 40)"":
     NORMAL
3700 VTAB 10:
     PRINT "THIS SOFTWARE HAS BEEN THOROUGHLY TESTEDPRIOR TO RELEASE. HOWEVER, CA
     NMET MAKES NO WARRANTY, EXPRESS OR IMPLIED, OF ITS FITNESS FOR ANY PARTICULA
     R PURPOSE."
3800 PRINT :
     PRINT "IN NO EVENT WILL QUEEN'S UNIVERSITY OR  CANMET BE LIABLE FOR DIRECT,
     INDIRECT,  OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECT THEREIN."
3900 VTAB 24:
     HTAB 5:
     INVERSE :
     PRINT " PRESS ANY KEY TO START...";:
     NORMAL :
     GET R$
```

```
                              +-------------------------+
4000                          !  CHAIN TO MAIN PROGRAM !
                              +-------------------------+

4100 VTAB 21:
     HTAB 9:
     INVERSE :
     PRINT " PLEASE WAIT WHILE ":
     HTAB 9:
     PRINT " PROGRAM IS LOADED ":
     NORMAL :
     CALL  - 958:
     PRINT D$;"BLOAD CHAIN,A520":
     CALL 520"CANMET"
```

```
J&L: REM LENGTH OF PROGRAM "HELLO"

PROGRAM LENGTH IS 2253 ($08CD) BYTES


J&C: REM SPACE TAKEN UP BY 'REM' STATEMENTS IN "HELLO"

840 ($0348) BYTES SAVED


J&X: REM VARIABLE CROSS-REFERENCE FOR "HELLO"

B      3200
B$     100
C$     100
D$     100, 4100
DF     1100
DI     1300
FF     700
GS     1500
I      3200
MM$    500
MW     800
M$(    2700, 2800
P$     100
P%     300
PI     100
PT     1000
R$     3900
S$     100
SH     600
TD     1200
U$     1800
U1$    2000
U2$    2100
U3$    2200
U4$    2300
U5$    2400
U6$    2500
X$     100
```

```
                          +--------------------------+
 10                       ! ************************ !
 15                       ! *                      * !
 20                       ! *    CANMET RISERING   * !
 25                       ! *                      * !
 30                       ! *     MAIN PROGRAM     * !
 35                       ! *                      * !
 40                       ! *    BY: M.R. VINER    * !
 45                       ! *    22 MARCH  1983    * !
 50                       ! *                      * !
 55                       ! ************************ !
                          +--------------------------+
100 K = 0:
    DEF FN P1(R) = INT(R * 10 + .5) / 10:
    DEF FN P2(R) = INT(R * 100 + .5) / 100:
    DEF FN P3(R) = INT(R * 1000 + .5) / 1000:
    GOTO 12700
                            +----------------------+
200                         !  *** SUBROUTINES ***  !
                            +----------------------+
300 HTAB L%:
    PRINT Q$;SPC( I - L% - LEN(Q$) + 1)"":
    RETURN
                                          +--+
400                                       !  !
                                          +--+
500 Q$ = ""
600 GET R$:
    IF R$ = B$ THEN
       RETURN
700 Q$ = Q$ + R$:
    GOTO 600
                                          +--+
800                                       !  !
                                          +--+
900 INVERSE :
    HTAB 1:
    PRINT Q$;:
    NORMAL :
    PRINT S$;
1000 L% = 1:
    Q$ = ""
1100 GET R$:
    IF R$ = CHR$(13) THEN
       RETURN
1200 L = ASC(R$):
    IF L < 32 AND L <  > 8GOTO 1100
1300 IF L = 8 THEN
       L% = L% - 2:
       PRINT R$" ";:
       IF L% < 0 THEN
          L% = 0:
```

```
            GOTO 1100
1400 PRINT R$;:
     L% = L% + 1:
     Q$ = Q$ + R$:
     GOTO 1100

                                          +--+
1500                                      !  !
                                          +--+

1600 INVERSE :
     HTAB 1:
     PRINT Q$;:
     NORMAL
1700 PRINT S$;:
     L% = 0:
     Q$ = "":
     R$(1) = ""
1800 GET R$:
     L = ASC(R$):
     IF L = 13GOTO 2300
1900 IF L = 8 THEN
        L% = L% - 1:
        IF L% < 0 THEN
           L% = 0:
           GOTO 1800
2000 IF L = 8 THEN
        PRINT R$" "R$;:
        GOTO 1800
2100 IF L < 46 OR L = 47 OR L > 57 THEN
        PRINT B$;:
        GOTO 1800
2200 PRINT R$;:
     L% = L% + 1:
     R$(L%) = R$:
     GOTO 1800
2300 IF L%GOTO 2600
2400 IF R THEN
        RETURN
2500 PRINT B$;:
     GOTO 1800
2600 FOR I = 1 TO L%:
        Q$ = Q$ + R$(I):
     NEXT :
     R = VAL(Q$):
     RETURN

                                          +--+
2700                                      !  !
                                          +--+

2800 VTAB 24:
     HTAB 1:
     PRINT "CHANGE ANY OF THE ABOVE?  ";
2900 INVERSE :
     PRINT "Y/N";:
```

```
     NORMAL :
     PRINT " ";:
     GET R$:
     IF R$ = "y" THEN
        R$ = "Y"
3000 HTAB 1:
     CALL  - 958:
     RETURN
                                          +--+
3100                                      !  !
                                          +--+
3200 PRINT "WHICH?  PRESS A NUMBER KEY...  ";
3300 GET R$:
     R% = VAL(R$):
     IF R% < 1 OR R% > L% THEN
        PRINT B$;:
        GOTO 3300
3400 PRINT R$:
     RETURN
                                          +--+
3500                                      !  !
                                          +--+
3600 VTAB 23:
     INVERSE :
     PRINT " PRESS ";:
     FLASH :
     PRINT "P";:
     INVERSE :
     PRINT " TO PRINT SCREEN,":
     HTAB 8:
     PRINT "ANY OTHER KEY TO CONTINUE...";:
     NORMAL :
     GET R$:
     VTAB 1:
     PRINT :
     RETURN
                                          +--+
3700                                      !  !
                                          +--+
3800 HOME :
     VTAB 10:
     HTAB 12:
     INVERSE :
     PRINT " PLEASE WAIT WHILE ":
     HTAB 12:
     PRINT " PROGRAM IS LOADED ":
     NORMAL :
     PRINT D$"BLOAD CHAIN,A520":
     RETURN
                                          +--+
3900                                      !  !
                                          +--+
```

```
4000 VTAB 24:
     HTAB 5:
     INVERSE :
     PRINT " PRESS ANY KEY TO CONTINUE...";:
     NORMAL :
     GET R$:
     VTAB 1:
     PRINT :
     RETURN
                                          +--+
4100                                      !  !
                                          +--+
4200 PRINT RIGHT$(X$ + STR$(INT(R)),L);:
     RETURN
4300 PRINT RIGHT$(X$ + STR$(FN P1(R)),L);:
     RETURN
4400 PRINT RIGHT$(X$ + STR$(FN P3(R)),L);:
     RETURN
                                          +--+
4500                                      !  !
                                          +--+
4600 MC = 0:
     FOR I = 0 TO 9:
        IF NOT SC(I)GOTO 4800
4700    VC = VC + VC(I):
        SC = SC + SC(I):
        AC = AC + AC(I):
        CN = CN + CN(I):
        M = VC(I) / SC(I):
        IF M > MC THEN
           MC = M
4800 NEXT I:
     RETURN
                          +-------------------------------+
4850                      !       CONVERSION OF UNITS:    !
4860                      !  L=+1 --> METRIC TO IMPERIAL  !
4870                      !  L=-1 --> IMPERIAL TO METRIC  !
4900                      !  TEMPERATURE CONVERSION       !
                          +-------------------------------+
5000 IF L = 1 THEN
        PT = PT * 1.8 + 32
5100 IF L < 0 THEN
        PT = (PT - 32) * 5 / 9
                                +----------------------+
5200                            !  VOLUME CONVERSION   !
                                +----------------------+
5300 Z = .061^ L:
     VC = Z * VC:
     VG = Z * VG:
     VN = Z * VN:
     RV = Z * RV:
     NV = Z * NV:
```

```
     CP = CP / Z:
     FOR I = 0 TO 9:
        VC(I) = Z * VC(I):
     NEXT
                                  +-------------------+
5400                              !  AREA CONVERSION  !
                                  +-------------------+
5500 Z = .155^ L:
     SC = Z * VC:
     AC = Z * AC:
     SN = Z * SN:
     AG = Z * AG:
     GA = Z * GA:
     AN = Z * AN:
     NC = Z * NC:
     CC = CC / Z:
     CH = CH / Z:
     CI = CI / Z:
     FOR I = 0 TO 9:
        SC(I) = Z * SC(I):
        AC(I) = Z * AC(I):
     NEXT
                                 +---------------------+
5600                             !  WEIGHT CONVERSION  !
                                 +---------------------+
5700 Z = .454^ L:
     TW = Z * TW:
     WT = Z * WT:
     WI = Z * WI:
     IW = Z * IW:
     CM = Z * CM:
     CR = Z * CR:
     CT = Z * CT
                                 +---------------------+
5800                             !  LENGTH CONVERSION  !
                                 +---------------------+
5900 Z = .3937^ L:
     RH = Z * RH:
     RD = Z * RD:
     NL = Z * NL:
     ND = Z * ND:
     TI = Z * TI:
     HS = Z * HS:
     HC = Z * HC:
     HD = Z * HD:
     SL = Z * SL:
     CS = CS / Z
                                +-----------------------+
6000                            !  DENSITY CONVERSION  !
                                +-----------------------+
6100 Z = .0361^ L:
     DF = Z * DF:
```

```
      TD = Z * TD
 6200 RETURN
                              +------------------------------+
 6300                         !  SHRINKAGE AS AN EMPIRICAL   !
 6400                         !  FUNCTION OF %C AND TEMP     !
 6500                         !  DIFFERENCE FROM 1600 C      !
                              +------------------------------+
 6600 SH = (9 * PC + 1) / (PC + .43):
      IF U$ = "I" THEN
         SH = SH + (1.25 + .3 * PC) * ((PT - 32) * 5 / 9 - 1600) / 100:
         GOTO 6800
 6700 SH = SH + (1.25 + .3 * PC) * (PT - 1600) / 100
 6800 SH = FN P2(SH):
      IF SH < 0 THEN
         SH = 0
 6900 RETURN
                            +--------------------------------+
 7000                       !    END (A) AND LATERAL (B)     !
 7100                       !  FEEDING DISTANCES IN INCHES   !
                            +--------------------------------+
 7200 IF T < 2 THEN
         A = (1.5 * T + 2 * Q) * FF:
         B = (1.56 * T + .25 * Q) * FF:
         RETURN
 7300 A = (1.51 * C + 7.24 * D - 5.67) * FF:
      B = (3.38 * C + .84 * D - 2.34) * FF:
      IF R% = 3 THEN
         A = (1.39 * C + 3.16 * D - 3.19) * FF
 7400 RETURN
                                    +--------------+
 7500                               !  WITH CHILL  !
                                    +--------------+
 7600 IF T < 2 THEN
         A = (T + 2.7 * Q) * FF:
         B = (.8 * T + 2.5 * Q) * FF
 7700 M = 2.24 * Q + 2.6 * C - 6.02 * D + 6:
      IF T < 2 THEN
         RETURN
 7800 A = (4.12 * C + 9.14 * D - 11.4) * FF:
      B = (.88 * T - .76 * Q - 1.64 * C + 10.8 * D + .21 * SQR(M) - 7.04) * FF:
      RETURN
                                          +--+
 7900                                     !  !
                                          +--+
 8000 G = F * A^ .333:
      G = F * (A + 2 * G)^ .333:
      H = F * B^ .333:
      H = F * (B + 2 * H)^ .333:
      RETURN
                       +-----------------------------------------+
 8100                  !  TAPER (S) FOR A GIVEN FEEDING DISTANCE  !
                       +-----------------------------------------+
```

```
8200 S = .0648 * T - .0164 * Q:
     R = (L - A - B) * S + T:
     V = ((L + A - B) * T + (L + B - A) * R) * W / 2:
     G = (SH * V / E)^ .333:
     G = (SH * (V + 2 * W * R * G) / E)^ .333:
     RETURN
                              +--------------------------+
8300                          !  FLUIDITY/ POURING TIME  !
8400                          !   GATE VOLUME & AREA     !
8500                          !    (IMPERIAL UNITS)      !
                              +--------------------------+
8600 F = .07 * T - 178:
     FL = F:
     RETURN
8700 TP = (1.733 - .116 * LOG(W)) * SQR(W):
     R = SN / 6 / VN^ .6667:
     VG = .05 * VN * (1 + LOG(R) * (R > 1))
8800 GA = 1.65 * V * GS / F / TP / SQR(D):
     RETURN
                                              +--+
8900                                          !  !
                                              +--+
9000 CALL  - 958:
     INVERSE :
     PRINT "NAME OF DISK FILE: ";:
     NORMAL :
     INPUT " ";F$:
     IF F$ = "" THEN
        POP :
        GOTO 12700
9100 RETURN
9200 PRINT D$"OPEN "F$:
     PRINT D$"READ "F$:
     RETURN
9300 PRINT D$"OPEN "F$:
     PRINT D$"WRITE "F$:
     RETURN
9400 PRINT D$"CLOSE "F$:
     RETURN
9500 PRINT D$"APPEND "F$:
     GOSUB 9400:
     ONERR GOTO 11600
9600 RETURN
                                              +--+
9700                                          !  !
                                              +--+
9800 IF PO$ <  > "" THEN
        RETURN
9900 GOSUB 48400:
     VTAB 8:
     HTAB 6:
     PRINT B$"CANNOT "A$" DATA UNTIL ":
```

```
      VTAB 10:
      HTAB 8:
      FLASH :
      PRINT " PURCHASE ORDER # ":
      NORMAL :
      VTAB 12:
      PRINT "IS ENTERED IN CUSTOMER/CASTING INFO!"B$:
      GOSUB 4000:
      POP :
      GOTO 12700
                                          +--+
10000                                     !  !
                                          +--+
10100 INVERSE :
      PRINT "SECTION NUMBER (0-9): ";:
      NORMAL :
      PRINT " ";
10200 GET R$:
      R = ASC(R$):
      IF R < 48 OR R > 57 THEN
         PRINT B$;:
         GOTO 10200
10300 F$ = "DATA" + R$ + "/" + LEFT$(PO$,20):
      RETURN
10400 GOSUB 9500:
      GOSUB 9200:
      INPUT VC,SC,AC,CN,RT,RH,RD,TW,CS,CI,TI,YD%,ND,NL,NR:
      FOR L = 0 TO 9:
         INPUT VC(L),SC(L),AC(L),CN(L):
      NEXT L:
      GOSUB 9400:
      RETURN
                                          +--+
10500                                     !  !
                                          +--+
10600 IF P$ = " ON" THEN
         PRINT D$"PR#"P%:
         P$ = "OFF":
         RETURN
10700 PRINT D$"PR#0":
      P$ = " ON":
      RETURN
                              +-----------------------+
10800                         !  ERROR HANDLER & EXIT  !
                              +-----------------------+
10900 VTAB 15:
      R% = 1:
      GOTO 11200
11000 VTAB 15:
      R% = 2:
      GOTO 11200
11100 VTAB 15:
```

```
      R% = 3
11200 R = PEEK(222):
      IF R = 8 THEN
         INVERSE :
         PRINT B$"I/O ERROR.";:
         NORMAL :
         PRINT " CHECK DISK DRIVE..."X$:
         GOSUB 4000:
         GOTO 12000
11300 IF R = 9 THEN
         INVERSE :
         PRINT B$"DISK FULL.";:
         CALL  - 958:
         NORMAL :
         PRINT :
         PRINT "DELETE SOME FILES OR CHANGE DISKS...":
         GOSUB 4000:
         GOTO 12000
11400 IF R = 10 THEN
         INVERSE :
         PRINT B$"FILE LOCKED.";:
         NORMAL :
         PRINT " TRY ANOTHER NAME..."X$:
         GOSUB 4000:
         GOTO 12000
11500 IF R = 11 THEN
         INVERSE :
         PRINT B$"BAD FILE NAME.";:
         NORMAL :
         PRINT " TRY AGAIN..."X$:
         GOSUB 4000:
         GOTO 12000
11600 HOME :
      VTAB 6:
      PRINT "EXIT ON ERROR NUMBER ";PEEK(222):
      VTAB 8:
      PRINT "AT LINE NUMBER ";PEEK(218) + 256 * PEEK(219):
      GOTO 11800
11700 HOME :
      VTAB 7:
      PRINT "THANK YOU AND GOOD DAY"
11800 VTAB 11:
      PRINT :
      PRINT "TO RESUME WITH THE SAME CASTING, TYPE:":
      HTAB 27:
      INVERSE :
      PRINT " GOTO 10 ":
      NORMAL :
      PRINT :
      PRINT "TO RUN A NEW CASTING, TYPE:"
11900 HTAB 27:
      INVERSE :
```

```
      PRINT " RUN HELLO ":
      NORMAL :
      PRINT :
      PRINT :
      END
12000 ON R%GOTO 46900,47500,47800,12700:
      END
                                          +--+
12100                                     !  !
                                          +--+
12200 IF PEEK(222) = 5GOTO 12500
12300 R% = 4:
      ONERR GOTO 11600
12400 GOTO 11200
12500 HTAB 1:
      CALL  - 958:
      PRINT B$"FILE NOT FOUND.  TRY AGAIN"B$:
      POP :
      GOSUB 4000:
      ON C%GOTO 13700,22400,42100,19200
                           +-------------------------+
12600                      !  **** MAIN PROGRAM ****  !
                           +-------------------------+
12700 HOME :
      INVERSE :
      PRINT " MAIN MENU FOR CANMET RISERING: ":
      PRINT SPC( 32)"":
      NORMAL :
      VTAB 5:
      I = FRE(0):
      P = 0:
      ONERR GOTO 11600
12800 PRINT "  1. INSTRUCTIONS/TUTORIAL":
      PRINT :
      PRINT "  2. CUSTOMER/CASTING INFO":
      PRINT :
      PRINT "  3. FEEDING DISTANCE"
12900 PRINT :
      PRINT "  4. CASTING SHAPE/SIZE":
      PRINT :
      PRINT "  5. RISER SIZE/NECK":
      PRINT :
      PRINT "  6. GATING SYSTEM"
13000 PRINT :
      PRINT "  7. COST ANALYSIS":
      PRINT :
      PRINT "  8. QUIT/STORE FILES ON DISK":
      PRINT :
      PRINT :
      L% = 8:
      GOSUB 3200
13100 ON R%GOTO 13300,13500,19900,24300,24500,36600,41800,46600
```

```
                          +----------------------------------+
13200                     !  *** INSTRUCTIONS/TUTORIAL ***  !
                          +----------------------------------+

13300 HOME :
      HTAB 6:
      INVERSE :
      PRINT "  INSTRUCTIONS/TUTORIAL  ":
      HTAB 6:
      PRINT SPC( 25)"":
      NORMAL :
      VTAB 10:
      PRINT "    PROGRAM NOT AVAILABLE YET":
      VTAB 12:
      PRINT "       PLEASE BE PATIENT.":
      GOSUB 4000:
      GOTO 12700
13350 GOSUB 3800:
      CALL 520"INSTRUCTIONS"
                          +----------------------------------+
13400                     !  *** CUSTOMER/CASTING INFO ***  !
                          +----------------------------------+

13500 GOSUB 19700:
      PRINT "GET CUSTOMER/CASTING INFO FROM DISK?";:
      GOSUB 2900:
      IF R$ <  > "Y" THEN
         VTAB 4:
         CALL  - 958:
         GOTO 14100
13600 C% = 1:
      ONERR GOTO 12200
13700 VTAB 5:
      GOSUB 9000:
      GOSUB 9500:
      GOSUB 9200
13800 GOSUB 500:
      UN$ = Q$:
      GOSUB 500:
      CN$ = Q$:
      GOSUB 500:
      CA$ = Q$:
      GOSUB 500:
      CC$ = Q$:
      GOSUB 500:
      PO$ = Q$:
      GOSUB 500:
      DT$ = Q$:
      GOSUB 500:
      CD$ = Q$:
      GOSUB 500:
      U$ = Q$:
      GOSUB 500:
      MM$ = Q$
```

```
13900 INPUT PC,DF,TD,SH,PT,FF,MW,GS,HS,HC,HD,NG,NA:
      GOSUB 9400
                                          +--+
14000                                     !  !
                                          +--+
14100 IF UN$ <  > "" OR CN$ <  > "" OR DT$ <  > ""GOTO 15400
14200 VTAB 7:
      Q$ = "YOUR NAME: ":
      GOSUB 900:
      IF L% > 1 THEN
         UN$ = Q$
14300 Q$ = UN$:
      VTAB 7:
      L% = 13:
      I = 120:
      GOSUB 300
14400 VTAB 10:
      Q$ = "CUSTOMER NAME: ":
      GOSUB 900:
      IF L% > 1 THEN
         CN$ = Q$
14500 Q$ = CN$:
      VTAB 10:
      L% = 17:
      I = 120:
      GOSUB 300
14600 VTAB 13:
      Q$ = "CUSTOMER ADDRESS: ":
      GOSUB 900:
      IF L% > 1 THEN
         CA$ = Q$
14700 Q$ = CA$:
      VTAB 13:
      L% = 20:
      I = 120:
      GOSUB 300
14800 VTAB 16:
      Q$ = "CUSTOMER CITY/PROV: ":
      GOSUB 900:
      IF L% > 1 THEN
         CC$ = Q$
14900 Q$ = CC$:
      VTAB 16:
      L% = 22:
      I = 120:
      GOSUB 300
15000 VTAB 19:
      Q$ = "PURCHASE ORDER #: ":
      GOSUB 900:
      IF L% > 1 THEN
         PO$ = Q$
15100 Q$ = PO$:
```

```
      VTAB 19:
      L% = 20:
      I = 80:
      GOSUB 300
15200 VTAB 21:
      Q$ = "TODAY'S DATE: ":
      GOSUB 900:
      IF L% > 1 THEN
         DT$ = Q$
15300 Q$ = DT$:
      VTAB 21:
      L% = 16:
      I = 80:
      GOSUB 300:
      GOTO 15600
15400 VTAB 7:
      INVERSE :
      PRINT "YOUR NAME: ";:
      NORMAL :
      PRINT S$UN$:
      VTAB 10:
      INVERSE :
      PRINT "CUSTOMER NAME: ";:
      NORMAL :
      PRINT S$CN$:
      VTAB 13:
      INVERSE :
      PRINT "CUSTOMER ADDRESS: ";:
      NORMAL :
      PRINT S$CA$
15500 VTAB 16:
      INVERSE :
      PRINT "CUSTOMER CITY/PROV: ";:
      NORMAL :
      PRINT S$CC$:
      VTAB 19:
      INVERSE :
      PRINT "PURCHASE ORDER #: ";:
      NORMAL :
      PRINT S$PO$:
      VTAB 21:
      INVERSE :
      PRINT "TODAY'S DATE: ";:
      NORMAL :
      PRINT S$DT$
15600 GOSUB 2800:
      IF R$ = "Y"GOTO 14200
                                          +--+
15700                                     !  !
                                          +--+
15800 GOSUB 19700:
      IF CD$ <  > "" OR PCGOTO 17400
```

```
15900 VTAB 5:
      Q$ = "CASTING DESCRIPTION: ":
      GOSUB 900:
      IF L% > 1 THEN
         CD$ = Q$
16000 Q$ = CD$:
      VTAB 5:
      L% = 23:
      I = 160:
      GOSUB 300
16100 VTAB 9:
      INVERSE :
      PRINT "UNITS? ";:
      FLASH :
      PRINT "I";:
      INVERSE :
      PRINT "MPERIAL OR ";:
      FLASH :
      PRINT "M";:
      INVERSE :
      PRINT "ETRIC: ";:
      NORMAL :
      PRINT S$U$;
16200 GET R$:
      IF R$ = CHR$(13) THEN
         PRINT R$:
         GOTO 16900
16300 IF R$ = "I" OR R$ = "i" THEN
         R$ = "I":
         GOTO 16600
16400 IF R$ = "M" OR R$ = "m" THEN
         R$ = "M":
         GOTO 16600
16500 PRINT B$;:
      GOTO 16200
16600 IF U$ = "M" AND R$ = "I" THEN
         L = 1:
         GOSUB 5000
16700 IF U$ = "I" AND R$ = "M" THEN
         L =  - 1:
         GOSUB 5000
16800 HTAB 29:
      PRINT R$:
      U$ = R$
16900 U1$ = "IN":
      U2$ = "LB":
      U3$ = "SQ.IN":
      U4$ = "CU.IN":
      U5$ = "F":
      U6$ = "LB/CU.IN":
      IF U$ = "M" THEN
         U1$ = "CM":
```

```
          U2$ = "KG":
          U3$ = "SQ.CM":
          U4$ = "CU.CM":
          U5$ = "C":
          U6$ = "GM/CU.CM"
17000 VTAB 12:
      INVERSE :
      PRINT "POURING TEMPERATURE ("U5$"): ";:
      NORMAL :
      PRINT S$;INT(PT);:
      HTAB 26:
      R = PT:
      GOSUB 1700:
      IF R <  > PT THEN
         PT = R:
         PRINT X$
17100 VTAB 15:
      Q$ = "% CARBON IN STEEL: ":
      R = PC:
      GOSUB 1600:
      IF R <  > PC THEN
         PC = R:
         PRINT X$
17200 HTAB 1:
      VTAB 18:
      INVERSE :
      PRINT "FEED METAL DENSITY ("U6$"): ";:
      NORMAL :
      PRINT S$;FN P2(DF);"    ";:
      VTAB 18:
      HTAB 32:
      R = DF:
      GOSUB 1700:
      IF R <  > DF THEN
         DF = R:
         PRINT X$
17300 GOSUB 6600:
      VTAB 21:
      HTAB 1:
      INVERSE :
      PRINT "FEED METAL SHRINKAGE (%): ";:
      NORMAL :
      PRINT S$;SH;"    ";:
      HTAB 27:
      R = SH:
      GOSUB 1700:
      SH = R:
      HTAB 28:
      PRINT SH;X$:
      GOTO 17600
17400 VTAB 5:
      INVERSE :
```

```
      PRINT "CASTING DESCRIPTION: ";:
      NORMAL :
      PRINT S$CD$:
      VTAB 9:
      INVERSE :
      PRINT "UNITS? IMPERIAL OR METRIC: ";:
      NORMAL :
      PRINT S$U$:
      VTAB 12:
      INVERSE :
      PRINT "POURING TEMPERATURE ("U5$"): ";:
      NORMAL
17500 PRINT S$INT(PT):
      VTAB 15:
      INVERSE :
      PRINT "% CARBON IN STEEL: ";:
      NORMAL :
      PRINT S$PC:
      VTAB 18:
      INVERSE :
      PRINT "FEED METAL DENSITY ("U6$"): ";:
      NORMAL :
      PRINT S$;FN P2(DF):
      VTAB 21:
      INVERSE :
      PRINT "FEED METAL SHRINKAGE (%): ";:
      NORMAL :
      PRINT S$SH
17600 GOSUB 2800:
      IF R$ = "Y"GOTO 15900
                                          +--+
17700                                     !  !
                                          +--+
17800 GOSUB 19700:
      VTAB 8:
      PRINT "MOLDING MATERIAL IS ":
      PRINT :
      INVERSE :
      HTAB 10:
      PRINT MM$:
      VTAB 15:
      NORMAL :
      PRINT "DO YOU WISH TO CHANGE IT? ";:
      GOSUB 2900:
      IF R$ <  > "Y" THEN
         GO TO 19200
17900 GOSUB 19700:
      VTAB 6:
      PRINT "   CHOICE OF MOLDING MATERIALS:":
      VTAB 9:
      PRINT "      1. SILICA SAND":
      PRINT :
```

```
      PRINT "       2. OLIVINE SAND":
      PRINT :
      PRINT "       3. CHROMITE SAND":
      PRINT :
      PRINT "       4. ZIRCON SAND"
18000 PRINT :
      PRINT :
      PRINT "   ";:
      L% = 4:
      GOSUB 3200:
      ON R%GOTO 18100,18200,18300,18400
18100 FF = 1.0:
      MW = 3.0:
      MM$ = "SILICA SAND ":
      GOTO 18500
18200 FF = .96:
      MW = 2.0:
      MM$ = "OLIVINE SAND ":
      GOTO 18500
18300 FF = .87:
      MW = 1.5:
      MM$ = "CHROMITE SAND ":
      GOTO 18500
18400 FF = .90:
      MW = 0.5:
      MM$ = "ZIRCON SAND "
18500 GOSUB 19700:
      VTAB 6:
      PRINT "   CHOICE OF MOLDING PROCESS:":
      VTAB 9:
      PRINT "       1. GREEN":
      PRINT :
      PRINT "       2. DRY":
      PRINT :
      PRINT "       3. NOBAKE":
      PRINT :
      PRINT "       4. SHELL":
      PRINT :
      PRINT :
      PRINT "   ";
18600 L% = 4:
      GOSUB 3200:
      ON R%GOTO 18700,18800,18900,19000
18700 MW = MW * 1.0:
      MM$ = " GREEN " + MM$:
      GOTO 19200
18800 MW = MW * 1.0:
      MM$ = " DRY " + MM$:
      GOTO 19200
18900 MW = MW * 0.5:
      MM$ = " NOBAKE " + MM$:
      GOTO 19200
```

```
19000 MW = MW * 0.2:
      MM$ = " SHELL " + MM$:
      GOTO 12700
                                          +--+
19100                                     !  !
                                          +--+
19200 GOSUB 19700:
      VTAB 8:
      PRINT "GET SECTION/RISER DATA FROM DISK? ";:
      GOSUB 2900:
      IF R$ <  > "Y"GOTO 12700
19300 A$ = " LOAD":
      GOSUB 9800:
      C% = 4:
      ONERR GOTO 12200
19400 VTAB 14:
      GOSUB 10100:
      GOSUB 10400
19500 VN = 0:
      SN = 0:
      NC = 0:
      RV = 0:
      NV = 0:
      AN = 0:
      WT = 0:
      IA = 0:
      IC = 0:
      SL = 0:
      SP = 0:
      MC = 0:
      TC = 0:
      GOTO 12700
                                       +-------+
19600                                  !  SUB  !
                                       +-------+
19700 HOME :
      HTAB 4:
      INVERSE :
      PRINT "  CUSTOMER/CASTING INFORMATION  ":
      HTAB 4:
      PRINT SPC( 32)"":
      NORMAL :
      I = FRE(0):
      VTAB 4:
      RETURN
                              +--------------------------+
19800                         !  *** FEEDING DISTANCE ***  !
                              +--------------------------+
19900 T = 0:
      W = 0:
      Z = 1:
      IF U$ = "M" THEN
```

```
          Z = 2.54
20000 GOSUB 23000:
      VTAB 7:
      Q$ = "EFFECTIVE SECTION THICKNESS (" + U1$ + "):"
20100 IF T THEN
         HTAB 35:
         PRINT FN P1(Z * T);:
         HTAB 35
20200 R = T * Z:
      GOSUB 1600:
      IF R <  > T * Z THEN
         T = R / Z:
         PRINT X$
20300 VTAB 10:
      Q$ = "EFFECTIVE SECTION WIDTH (" + U1$ + "):"
20400 IF W THEN
         HTAB 31:
         PRINT FN P1(Z * W);:
         HTAB 31
20500 R = W * Z:
      GOSUB 1600:
      IF R <  > W * Z THEN
         W = R / Z:
         PRINT X$
20600 IF T > W THEN
         C = T:
         T = W:
         W = C
20700 R = W / T:
      Q = W:
      IF R > 2 THEN
         Q = 2 * T
20800 C = SQR(T):
      D = SQR(Q):
      E = 3 * PI * (20 - SH):
      F = (T * W * SH / E)^ .333
20900 IF T < 2 THEN
         VTAB 17:
         PRINT B$"TREAT THE FOLLOWING VALUES WITH CAUTION":
         PRINT :
         PRINT "GATING HAS A SIGNIFICANT EFFECT ON":
         PRINT :
         PRINT "FEEDING DISTANCE FOR THICKNESS < ";INT(Z * 2);S$U1$
21000 GOSUB 4000
21100 GOSUB 23000:
      VTAB 7:
      PRINT "    1. NO CHILLS OR TAPER":
      VTAB 9:
      PRINT "    2. END OR DRAG CHILLS":
      VTAB 11:
      PRINT "    3. TAPERED SECTION (PADDING)":
      VTAB 13:
```

```
      PRINT "   4. NEW SECTION SIZE"
21200 VTAB 15:
      PRINT "   5. ";:
      INVERSE :
      PRINT "PRINT";:
      NORMAL :
      PRINT " SIZE/DISTANCE TABLE ENTRY":
      VTAB 17:
      PRINT "   6. RETURN TO MAIN MENU":
      VTAB 21:
      L% = 6:
      GOSUB 3200
21300 ON R%GOTO 21400,21500,21600,20000,21900,12700
21400 F$ = " TOWARDS":
      Q$ = "ANOTHER RISER":
      GOSUB 23000:
      R$ = "NO CHILLS OR TAPER":
      GOSUB 22800:
      GOSUB 7200:
      GOSUB 8000:
      GOSUB 23200:
      GOSUB 23400:
      GOSUB 4000:
      GOTO 21100
21500 F$ = "TO EDGE OF":
      Q$ = " DRAG CHILL":
      GOSUB 23000:
      R$ = "END OR DRAG CHILLS":
      GOSUB 22800:
      GOSUB 7600:
      GOSUB 8000:
      GOSUB 23200:
      GOSUB 23400:
      GOSUB 4000:
      GOTO 21100
21600 R$ = " TAPERED SECTION":
      GOSUB 22800:
      NORMAL :
      VTAB 10:
      PRINT "LENGTH TO BE FED ("U1$"):";:
      R = 0:
      GOSUB 1700:
      L = R / Z:
      PRINT :
      IF NOT CP THEN
         VTAB 14:
         PRINT "COST OF GRINDING OFF PADS ($/"U4$"): ";:
         R = 0:
         PRINT :
         HTAB 18:
         GOSUB 1700:
         CP = R:
```

```
        PRINT
21700 GOSUB 7200:
      IF L < (A + B) THEN
         VTAB 18:
         PRINT B$"FOR THAT LENGTH, YOU DON'T NEED TAPER!":
         GOSUB 4000:
         GOTO 21100
21800 GOSUB 8200:
      GOSUB 23200:
      GOSUB 23900:
      GOSUB 4000:
      GOTO 21100
21900 L = 6:
      PRINT D$"PR# "P%:
      IF P THEN
         GO TO 22400
22000 P = 1:
      PRINT :
      PRINT :
      PRINT SPC( 10)"FEEDING DISTANCE TABLE  ("U1$")  FOR  ";FN P1(PC)" % C  STEEL
       IN "MM$
22100 PRINT :
      PRINT "+";:
      FOR I = 1 TO 93:
         PRINT "-";:
      NEXT :
      PRINT "+"
22200 PRINT "!   SECTION SIZE   !     NO CHILL     !                 END OR DRAG CHILL
             !     TAPER    !";
      PRINT "!"SPC( 18)"!"SPC( 18)"!"SPC( 18)"  CHILL    DRAG CHILL !
       !"
22300 PRINT "! THICKNESS  WIDTH !   END   LATERAL  !   END   LATERAL  THICKNESS
       WIDTH    !  SLOPE   END !";
      PRINT "!-----------------!----------------!-------------------------------
      ---------!-------------!"
22400 PRINT "! ";:
      R = T * Z:
      GOSUB 4300:
      PRINT "   ";:
      R = W * Z:
      GOSUB 4300:
      PRINT "  ! ";:
      GOSUB 7200:
      R = A * Z:
      GOSUB 4300:
      PRINT "  ";:
      R = B * Z:
      GOSUB 4300:
      PRINT "   !";:
      GOSUB 7600:
      R = A * Z:
      GOSUB 4300:
```

```
      PRINT "   ";:
      R = B * Z
22500 GOSUB 4300:
      PRINT "    ";:
      R = .6 * T * Z:
      GOSUB 4300:
      PRINT "    ";:
      R = M * Z:
      GOSUB 4300:
      PRINT "     !";:
      R = .0648 * T - .0164 * Q:
      GOSUB 4400:
      PRINT " ";:
      R = (1.39 * C + 3.16 * D - 3.19) * FF * Z:
      GOSUB 4300:
      PRINT " !"
22600 PRINT "!.................!.................!.............................
      ..........!............!":
      PRINT D$"PR#0":
      GOTO 21100
                                      +--------+
22700                                 ! SUBS   !
                                      +--------+
22800 GOSUB 23000:
      HTAB 9:
      INVERSE :
      PRINT R$:
      RETURN
                                        +--+
22900                                   !  !
                                        +--+
23000 HOME :
      HTAB 7:
      INVERSE :
      PRINT "   FEEDING DISTANCE   ":
      HTAB 7:
      PRINT SPC( 22)"":
      NORMAL :
      I = FRE(0):
      VTAB 2:
      RETURN
                                        +--+
23100                                   !  !
                                        +--+
23200 GOSUB 8100:
      VTAB 4:
      CALL  - 958:
      INVERSE :
      PRINT "THICKNESS:";:
      NORMAL :
      PRINT S$S$;T * Z;S$U1$;:
      HTAB 22:
```

```
      INVERSE :
      PRINT "WIDTH:";:
      NORMAL :
      PRINT S$S$;W * Z;S$U1$:
      RETURN
                                          +--+
23300                                     !  !
                                          +--+
23400 VTAB 7:
      HTAB 19:
      PRINT "TOWARDS    "F$:
      HTAB 19:
      PRINT "AN END    "Q$
23500 VTAB 10:
      PRINT "FEEDING DISTANCE";:
      HTAB 19:
      PRINT FN P1(A * Z);:
      HTAB 24:
      PRINT U1$;:
      HTAB 30:
      PRINT FN P1(B * Z);:
      HTAB 35:
      PRINT U1$:
      HTAB 7:
      PRINT "FROM RISER"
23600 VTAB 13:
      PRINT "APPROX. RADIUS";:
      HTAB 19:
      PRINT FN P1(G * Z);:
      HTAB 24:
      PRINT U1$;:
      HTAB 30:
      PRINT FN P1(H * Z);:
      HTAB 35:
      PRINT U1$:
      HTAB 7:
      PRINT "OF RISER":
      IF R% <  > 2 THEN
         RETURN
23700 VTAB 19:
      PRINT "SUGGESTED CHILL THICKNESS IS  ";FN P1(.6 * T * Z);:
      HTAB 36:
      PRINT U1$:
      VTAB 21:
      PRINT "MAX. WIDTH FOR DRAG CHILL IS  ";FN P1(M * Z);:
      HTAB 36:
      PRINT U1$:
      RETURN
                                          +--+
23800                                     !  !
                                          +--+
23900 VTAB 6:
```

```
      PRINT " TAPER:  ";FN P3(S);S$U1$"/"U1$;:
      INVERSE :
      HTAB 21:
      PRINT "LENGTH:";:
      NORMAL :
      PRINT S$S$;L * Z;S$U1$:
      VTAB 9:
      PRINT "TAPER STARTS  ";FN P1(A * Z);S$U1$"  FROM END":
      PRINT "   AND STOPS  ";FN P1(B * Z);S$U1$;
24000 PRINT "  FROM RISER":
      VTAB 12:
      PRINT "   THICKNESS AT RISER IS  ";FN P1(R * Z);S$U1$:
      PRINT "APPROXIMATE RISER RADIUS  ";FN P1(G * Z);S$U1$
24100 V = (V - T * W * L) * Z^ 3:
      VTAB 15:
      PRINT "VOLUME TO BE GROUND OFF:  ";INT(V);S$U4$:
      HTAB 12:
      PRINT "AT A COST OF: $";INT((CP + CM * DF) * V):
      RETURN
                          +------------------------------+
24200                     !  *** CASTING SHAPE/SIZE ***  !
                          +------------------------------+
24300 GOSUB 3800:
      CALL 520"SHAPE MENU"
                            +---------------------------+
24400                       !  *** RISER SIZE/NECK ***  !
                            +---------------------------+
24500 F = (SH + MW) / 100:
      F$ = "":
      IF VCGOTO 24800
24600 GOSUB 4600:
      IF VCGOTO 24800
24700 GOSUB 33100:
      VTAB 8:
      PRINT B$"CANNOT FIND RISER SIZE UNTIL AFTER":
      PRINT :
      HTAB 6:
      FLASH :
      PRINT " CASTING SHAPE/SIZE ":
      NORMAL :
      PRINT :
      PRINT "   OPTION HAS BEEN COMPLETED."B$:
      PRINT :
      GOSUB 4000:
      GOTO 12700
24800 CA = 0:
      K = 0:
      GOSUB 33100:
      VTAB 4:
      FOR I = 1 TO 7:
         PRINT :
         PRINT "  "I"."M$(I):
```

```
      NEXT :
      PRINT :
      PRINT "  8. RETURN TO MAIN MENU":
      VTAB 23:
      L% = 8:
      GOSUB 3200:
      IF R% < 8 THEN
         RT = R%
24900 A$ = "SLEEVE ":
      ON R%GOTO 25000,25100,25200,25300,25400,25500,25600,31050
25000 B = 0.7:
      GOSUB 33300:
      GOTO 26100
25100 GOTO 25800
25200 B = 1:
      GOSUB 33300:
      GOTO 26100
25300 B = 2:
      GOSUB 33300:
      GOTO 26100
25400 A$ = " RISER ":
      A = 1:
      B = 0.7:
      E = 1.2:
      GOTO 26400
25500 A$ = " RISER ":
      A = 1:
      B = 1:
      E = 1.2:
      GOTO 26400
25600 A$ = " RISER ":
      A = 1:
      B = 2:
      E = 1.2:
      GOTO 26400

                                          +--+
25700                                     !  !
                                          +--+

25800 GOSUB 33300:
      VTAB 8:
      PRINT "WHAT IS THE APPARENT SURFACE ALTERATION":
      PRINT :
      PRINT "FACTOR (ASAF) FOR THE TOP INSULATION? ":
      PRINT :
      HTAB 15:
      R = 0:
      GOSUB 1700:
      B = R:
      PRINT
25900 IF NOT CI THEN
         VTAB 15:
         PRINT "COST OF TOP INSULATION ($/"U2$"): ";:
```

```
          R = 0:
          GOSUB 1700:
          CI = R:
          PRINT
26000 VTAB 18:
      PRINT "THICKNESS OF TOP INSULATION ("U1$"): ";:
      R = 0:
      GOSUB 1700:
      TI = R:
      PRINT
26100 E = 1.1:
      VTAB 8:
      CALL  - 958:
      PRINT "SELECT FROM STOCK SLEEVES?";:
      GOSUB 2900:
      IF R$ = "Y" THEN
         GOTO 31200
26200 GOSUB 33300:
      VTAB 10:
      PRINT "WHAT IS THE APPARENT SURFACE ALTERATION":
      PRINT :
      PRINT "FACTOR (ASAF) FOR THE SLEEVE? ":
      PRINT :
      HTAB 15:
      R = 0:
      GOSUB 1700:
      A = R:
      PRINT
26300 VTAB 17:
      PRINT "COST OF THE SLEEVE ($/"U3$"): ";:
      R = 0:
      GOSUB 1700:
      CA = R:
      PRINT
26400 C = E * MC:
      GOSUB 33300:
      VTAB 6:
      PRINT "  1. RISER WITH FIXED DIAMETER":
      PRINT :
      PRINT "  2. RISER WITH FIXED HEIGHT":
      PRINT :
      PRINT "  3. RISER WITH FIXED HT/DIAM RATIO"
26500 PRINT :
      PRINT "  4. COMPUTER SELECTED HT/DIAM RATIOS":
      PRINT :
      PRINT "  5. SET RISER NECK":
      PRINT :
      PRINT "  6. ";:
      INVERSE :
      PRINT "PRINT";:
      NORMAL :
      PRINT " LAST RISER ANALYSIS":
```

```
      PRINT
26600 PRINT "  7. RETURN TO RISER TYPE MENU":
      PRINT :
      PRINT "  8. RETURN TO MAIN MENU":
      PRINT :
      PRINT :
      IF NOT ND THEN
         ND = RD
26700 L% = 8:
      GOSUB 3200:
      ON R%GOTO 26800,27100,27700,28100,28700,28700,24800,31050
26800 VTAB 23:
      HTAB 1:
      CALL  - 958:
      Q$ = "REQUIRED DIAMETER (" + U1$ + "): ":
      R = 0:
      GOSUB 1600:
      RD = R:
      L = RD - 4 * A * C:
      R$ = "FIXED":
      PRINT
26900 IF L < 0 THEN
         A$ = "SMALL":
         GOSUB 32450:
         GOTO 26400
27000 GOSUB 35400:
      GOSUB 36100:
      GOSUB 36200:
      GOSUB 4000:
      GOTO 26400
27100 VTAB 23:
      HTAB 1:
      CALL  - 958:
      Q$ = "REQUIRED HEIGHT (" + U1$ + "): ":
      R = 0:
      GOSUB 1600:
      RH = R:
      L = RH - B * C:
      PRINT :
      GOSUB 34000:
      H = RH:
      GOSUB 34300
27200 IF RT = 1 OR RT = 5 THEN
         H = RH - .1 * RD:
         L = H - B * C:
         GOSUB 34000:
         GOSUB 34300
27300 IF RT = 2 THEN
         H = RH - TI:
         L = H - B * C:
         GOSUB 34000:
         GOSUB 34300
```

```
27400 GOSUB 34900:
      GOSUB 35400:
      VTAB 12:
      PRINT A$"DIAMETER ("U1$"): ";FN P1(RD):
      VTAB 13:
      INVERSE :
      PRINT "FIXED";:
      NORMAL :
      PRINT "  HEIGHT   ("U1$"): ";RH:
      GOSUB 35700:
      VTAB 16:
      PRINT "SECTION YIELD (%): ";YD%
27500 GOSUB 35100:
      IF RT = 1 OR RT = 2 OR RT = 5 THEN
         GOSUB 35900
27600 GOSUB 4000:
      GOTO 26400
27700 VTAB 23:
      HTAB 1:
      Q$ = "REQUIRED HEIGHT/DIAMETER RATIO: ":
      R = 0:
      GOSUB 1600:
      G = R:
      C = C * (4 * A * G + B) / G:
      L = 4 * F * VC / PI / G:
      PRINT :
      GOSUB 34500:
      GOSUB 34900:
      GOSUB 35400
27800 VTAB 11:
      INVERSE :
      PRINT "HEIGHT/DIAMETER :";:
      NORMAL :
      PRINT " ";G:
      VTAB 13:
      PRINT A$"DIAM ("U1$"): ";FN P1(RD):
      VTAB 14:
      PRINT A$" HT  ("U1$"): ";FN P1(RH):
      VTAB 16:
      PRINT "RISER YIELD  (%): ";YD%
27900 GOSUB 35100:
      IF RT = 1 OR RT = 2 OR RT = 5 THEN
         GOSUB 36050:
         PRINT FN P1(TW + WI)
28000 GOSUB 4000:
      GOTO 26400
28100 GOSUB 35400:
      VTAB 11:
      INVERSE :
      PRINT "HEIGHT/DIAMETER :";:
      NORMAL :
      PRINT "  0.5     1.0     1.5":
```

```
      VTAB 13:
      PRINT A$"DIAM ("U1$"): ":
      VTAB 14:
      PRINT A$" HT  ("U1$"): "
28200 VTAB 16:
      PRINT "SECTION YIELD(%): ":
      IF RT = 1 OR RT = 2 OR RT = 5 THEN
         GOSUB 36050
28300 Q = C:
      FOR I = 1 TO 3:
         G = I / 2:
         C = Q * (4 * A * G + B) / G:
         L = 4 * F * VC / PI / G:
         GOSUB 34500:
         GOSUB 34900:
         VTAB 13:
         HTAB (12 + 8 * I):
         PRINT FN P1(RD):
         VTAB 14:
         HTAB (12 + 8 * I):
         PRINT FN P1(RH):
         VTAB 16:
         HTAB (13 + 8 * I):
         PRINT YD%
28400    GOSUB 35100:
         IF RT = 1 OR RT = 2 OR RT = 5 THEN
            VTAB 18:
            HTAB (12 + 8 * I):
            PRINT FN P1(TW + WI)
28500 NEXT :
      GOSUB 4000:
      GOTO 26400
                                          +--+
28600                                     !  !
                                          +--+
28700 IF NOT RD THEN
         INVERSE :
         VTAB 23:
         CALL  - 958:
         PRINT B$"NO RISER ANALYSIS YET. CHOOSE AGAIN...";:
         NORMAL :
         GOSUB 3300:
         GOTO 26700
28800 IF R% = 5GOTO 30500
28900 GOSUB 10100:
      PRINT :
      PRINT D$"PR#"P%:
      L = 8:
      PRINT :
      PRINT :
      PRINT :
      PRINT "  RISER SUMMARY FOR SECTION  "R$"  OF  ";LEFT$(CD$,45):
```

```
      HTAB 35:
      PRINT MID$(CD$,46,45)
29000 PRINT :
      PRINT "  BY:  ";LEFT$(UN$,35);TAB( 50)"FOR:  ";LEFT$(CN$,35):
      PRINT SPC( 55);LEFT$(CA$,35):
      PRINT "  PURCHASE ORDER #:  ";LEFT$(PO$ + X$ + X$,20);SPC( 14);LEFT$(CC$,35)
      :
      PRINT :
      PRINT SPC( 14)"DATE:  "DT$
29100 PRINT :
      PRINT :
      PRINT "       SUB      WEIGHT    VOLUME      AREA      MODULUS      #
      CHILL":
      PRINT "     SECTION     ("U2$")     ("U4$")    ("U3$")     ("U1$")      CHIL
      LS    AREA"
29200 PRINT "     -------    ------    -------    -------    -------    ------
      -----":
      PRINT :
      FOR I = 0 TO 9:
         IF NOT VC(I)GOTO 29500
29300    HTAB 9:
         PRINT I"    ";:
         R = VC(I) * DF:
         GOSUB 4300:
         PRINT "   ";:
         R = VC(I):
         GOSUB 4300:
         PRINT "   ";
29400    R = SC(I):
         GOSUB 4300:
         PRINT "  ";:
         R = VC(I) / SC(I):
         GOSUB 4300:
         PRINT " ";:
         R = CN(I):
         GOSUB 4200:
         PRINT "   ";:
         R = AC(I):
         GOSUB 4300:
         PRINT
29500 NEXT :
      HTAB 17:
      PRINT "------    -------    -------    =======    ------    -----";
      HTAB 8:
      PRINT "SUMS: ";:
      R = VC * DF:
      GOSUB 4300:
      PRINT "   ";:
      R = VC:
      GOSUB 4300:
      PRINT "   ";:
      R = SC:
```

```
      GOSUB 4300:
      PRINT "   ";
29600 R = VC / SC:
      GOSUB 4300:
      PRINT " ";:
      R = CN:
      GOSUB 4200:
      PRINT "    ";:
      R = AC:
      GOSUB 4300:
      PRINT :
      PRINT :
      PRINT :
      PRINT :
      PRINT "    RISER TYPE:   ";LEFT$(M$(RT) + X$,30);SPC( 5)"MOLDING MATERIAL: ";M
      M$:
      PRINT :
      PRINT
29700 HTAB 15:
      PRINT "APPARENT SURFACE ALTERATION FACTOR,  TOP: ";B:
      PRINT SPC( 50)"SIDE: ";A:
      PRINT :
      PRINT :
      PRINT "    RISER HEIGHT/DIAMETER:  ";G;TAB( 50)"LIQUID DEMAND ("U2$"):  ";FN
      P1((SH + MW) * VC * DF / 100)
29800 HTAB 5:
      PRINT A$"DIAMETER ("U1$"):  ";FN P1(RD):
      GOSUB 34900:
      HTAB 5:
      PRINT A$" HEIGHT  ("U1$"):  ";FN P1(RH);TAB( 50);"SECTION YIELD  (%):  ";YD%
29950 IF NL THEN
         PRINT :
         PRINT "      NECK  DIAMETER ("U1$"):  ";FN P1(ND):
         PRINT "      NECK   LENGTH  ("U1$"):  ";FN P1(NL)
30000 PRINT :
      PRINT :
      IF RT = 2 THEN
         HTAB 23:
         PRINT "TOP INSULATION WEIGHT ("U2$"):  ";FN P2(WI):
         PRINT
30100 IF RT = 1 OR RT = 5 THEN
         HTAB 23:
         PRINT "HOT TOPPING:  ";FN P1(TW);S$;U2$"  OF THERMIT"
30200 PRINT :
      PRINT :
      IF RT = 4 OR RT = 7 THEN
         PRINT M$(8)
30300 PRINT :
      PRINT D$"PR#0":
      IF KGOTO 24800
30350 GOTO 26400
```

+--+

```
30400                                          ! !
                                               +--+

30500 GOSUB 33300:
      NL = .5 * RD:
      ND = .7 * RD:
      VTAB 12:
      INVERSE :
      PRINT "NECK DIAMETER ("U1$"): ";:
      NORMAL :
      PRINT S$;FN P1(ND):
      VTAB 15:
      INVERSE :
      PRINT "NECK LENGTH ("U1$"): ";:
      NORMAL :
      PRINT S$;FN P1(NL):
      GOTO 30900
30700 VTAB 12:
      Q$ = "NECK DIAMETER (" + U1$ + "): ":
      R = ND:
      GOSUB 1600:
      IF R <  > ND THEN
         ND = R:
         PRINT X$
30800 VTAB 15:
      Q$ = "NECK LENGTH (" + U1$ + "): ":
      R = NL:
      GOSUB 1600:
      IF R <  > NL THEN
         NL = R:
         PRINT X$
30900 GOSUB 2800:
      IF R$ = "Y"GOTO 30700
30950 IF KGOTO 32020
31000 GOTO 26400
31050 K = 0:
      GOSUB 33300:
      VTAB 10:
      PRINT "HOW MANY IDENTICAL SECTIONS ARE THERE":
      PRINT :
      PRINT "WITH THIS RISER DESIGN?  ";:
      R = 1:
      GOSUB 1700:
      NR = R:
      GOTO 12700
                                               +--+
31100                                          ! !
                                               +--+

31200 C = E * MD:
      IF F$ <  > ""GOTO 31400
31300 VTAB 10:
      INVERSE :
      PRINT "NAME OF DISK FILE: ";:
```

```
      NORMAL :
      INPUT " ";F$:
      IF F$ = ""GOTO 22400
31400 C% = 2:
      ONERR GOTO 12200
31500 GOSUB 9500:
      PRINT D$"OPEN "F$
31600 VTAB 12:
      CALL  - 958:
      PRINT "AUTO SCANNING OF SLEEVE FILE? ";:
      GOSUB 2900:
      IF R$ = "Y"GOTO 32200
31700 ONERR GOTO 32700
31800 VTAB 15:
      PRINT "SLEEVE DIAMETER ("U1$"): ";:
      R = 0:
      GOSUB 1700:
      D = R:
      PRINT
31900 GOSUB 33500:
      IF ABS(D - RD) > .05 * D THEN
         GOTO 31900
31910 GOSUB 9400:
      ONERR GOTO 11600
31920 L = RD - 4 * A * C:
      IF L < 0 THEN
         A$ = "SMALL":
         GOSUB 34250:
         GOTO 31600
31930 GOSUB 36100:
      IF H / RD < .5 THEN
         A$ = "SMALL":
         GOSUB 34250:
         GOTO 31600
31940 IF H / RD > 2 THEN
         A$ = "LARGE":
         GOSUB 34250:
         GOTO 31600
32000 R$ = "STOCK":
      GOSUB 35400:
      GOSUB 36200:
      GOSUB 4000
32010 GOSUB 33300:
      VTAB 8:
      PRINT "DO YOU WANT A RISER NECK? ";:
      GOSUB 2900:
      IF R$ = "Y" THEN
         K = 1:
         GOTO 30500
32020 VTAB 10:
      HTAB 1:
      CALL  - 958:
```

```
      PRINT "SEND RISER ANALYSIS TO PRINTER? ";:
      GOSUB 2900:
      IF R$ = "Y" THEN
         K = 1:
         GOTO 24800
32030 GOTO 28900
                                          +--+
32100                                     !  !
                                          +--+
32200 R$ = "STOCK":
      ONERR GOTO 32800
32300 GOSUB 33500:
      L = RD - 4 * A * C:
      IF L < 0 THEN
         GO TO 32300
32400 GOSUB 36100:
      IF H / RD > .49 AND H / RD < 2.1 THEN
         GOSUB 35400:
         GOSUB 36200:
         INVERSE :
         VTAB 23:
         PRINT "PRESS ";:
         FLASH :
         PRINT "M";:
         INVERSE :
         PRINT " TO RETURN TO MENU,":
         GOSUB 4000:
         IF R$ <  > "M" AND R$ <  > "m"GOTO 32300
32450 PRINT :
      PRINT B$"DIAMETER TOO "A$" TO FEED THIS CASTING":
      RD = 0:
      GOSUB 4000:
      RETURN
                                          +--+
32460                                     !  !
                                          +--+
32500 GOSUB 9400:
      ONERR GOTO 11600
32550 GOTO 22400
                                          +--+
32600                                     !  !
                                          +--+
32700 VTAB 19:
      INVERSE :
      PRINT B$"END OF DISK FILE: DIAMETER NOT FOUND!":
      NORMAL :
      GOSUB 9400:
      GOSUB 4000:
      ONERR GOTO 11600
32750 GOTO 31600
32800 VTAB 22:
      INVERSE :
```

```
      PRINT "NO MORE SUITABLE SLEEVES IN STOCK":
      NORMAL :
      CALL  - 958:
      GOSUB 9400:
      GOSUB 4000:
      GOSUB 33300:
      ONERR GOTO 11600
32900 GOTO 22400
                                          +--------+
33000                                     !  SUBS  !
                                          +--------+
33100 HOME :
      HTAB 7:
      INVERSE :
      PRINT "  RISER SIZE/NECK  ":
      HTAB 7:
      PRINT SPC( 19)"":
      NORMAL :
      I = FRE(0):
      RETURN
                                            +--+
33200                                       !  !
                                            +--+
33300 GOSUB 33100:
      PRINT :
      HTAB (34 - LEN(M$(RT))) / 2:
      INVERSE :
      PRINT M$(RT):
      NORMAL :
      RETURN
                                            +--+
33400                                       !  !
                                            +--+
33500 PRINT :
      PRINT D$"READ "F$:
      INPUT RD,A,CS,R$:
      PRINT D$
33600 IF R$ = "I" AND U$ = "M" THEN
         RD = RD * 2.54:
         CS = CS / 2.54:
         RETURN
33700 IF R$ = "M" AND U$ = "I" THEN
         RD = RD / 2.54:
         CS = CS * 2.54
33800 RETURN
                                          +--+
33900                                     !  !
                                          +--+
34000 IF L < 0 THEN
         PRINT :
         PRINT B$"HEIGHT TOO SMALL TO FEED THIS CASTING":
         GOSUB 4000:
```

```
        POP :
        GOTO 26400
34100 RETURN
                                          +--+
34200                                     !  !
                                          +--+
34250 PRINT :
      PRINT B$"DIAMETER TOO SMALL TO FEED THIS CASTING":
      RD = 0:
      GOSUB 4000:
      RETURN
                                          +--+
34260                                     !  !
                                          +--+
34300 RD = (SQR(1 + F * L * VC / (A * C * H)^ 2) + 1) * 2 * A * C * H / L:
      RETURN
                                          +--+
34400                                     !  !
                                          +--+
34500 D = L^ .333
34600 RD = (C * D * D + L)^ .333:
      IF ABS(RD - D) > .01 * RD THEN
         D = RD:
         GOTO 34600
34700 H = G * RD:
      RH = H + .1 * RD * (RT = 1 OR RT = 5) + TI * (RT = 2):
      RETURN
                                          +--+
34800                                     !  !
                                          +--+
34900 YD% = 100 * VC / (VC + PI * H * RD * RD / 4 + PI * NL * ND * ND / 4):
      WI = DI * TI * PI * RD * RD / 4 * (RT = 2):
      RETURN
                                          +--+
35000                                     !  !
                                          +--+
35100 TW = .025 * PI * TD * RD^ 3 * (RT = 1 OR RT = 5):
      IF (CA) THEN
         CS = CA * PI * RD
35200 RETURN
                                          +--+
35300                                     !  !
                                          +--+
35400 GOSUB 33300:
      VTAB 7:
      PRINT "APPARENT SURFACE ALTERATION FACTOR:":
      HTAB 31:
      PRINT "TOP = ";B:
      HTAB 30:
      PRINT "SIDE = ";A:
      IF RT = 4 OR RT = 7 THEN
         VTAB 20:
```

```
        INVERSE :
        PRINT M$(8):
        NORMAL
35500 RETURN
                                          +--+
35600                                     !  !
                                          +--+
35700 VTAB 13:
      HTAB 29:
      PRINT "HT/DIAM= ";FN P1(H / RD):
      RETURN
                                          +--+
35800                                     !  !
                                          +--+
35900 IF RT = 2 THEN
        VTAB 18:
        PRINT "  TOP INSULATION: ";:
        INVERSE :
        PRINT FN P1(WI);:
        NORMAL :
        PRINT S$U2$:
        RETURN
35910 VTAB 18:
      PRINT "  HOT TOPPING  : ";:
      INVERSE :
      PRINT FN P1(TW);:
      NORMAL :
      PRINT " "U2$"  OF THERMIT":
      RETURN
                                          +--+
36000                                     !  !
                                          +--+
36050 IF RT = 2 THEN
        VTAB 18:
        PRINT "TOP INSULTN ("U2$"): ";:
        RETURN
36060 VTAB 18:
      PRINT "HOT TOPPING ("U2$"): ";:
      RETURN
                                          +--+
36070                                     !  !
                                          +--+
36100 H = (B * C * RD / SC + 4 * F / PI / RD) * VC / L:
      RH = H + .1 * RD * (RT = 1 OR RT = 5) + TI * (RT = 2):
      RETURN
36200 GOSUB 34900:
      VTAB 12:
      INVERSE :
      PRINT R$;:
      NORMAL :
      PRINT " DIAMETER ("U1$"): ";FN P1(RD);X$
36300 VTAB 13:
```

```
      PRINT A$"HEIGHT  ("U1$"): ";FN P1(RH);X$:
      GOSUB 35700:
      VTAB 16:
      PRINT "RISER YIELD (%): ";YD%"   ":
      GOSUB 35100:
      IF RT = 1 OR RT = 2 OR RT = 5 THEN
         GOSUB 35900
36400 RETURN
                              +-------------------------+
36500                         !  *** GATING SYSTEM ***  !
                              +-------------------------+
36600 GOSUB 41600:
      IF NOT NG THEN
         VTAB 5:
         HTAB 24:
         PRINT GS:
         GOTO 36900
36700 VTAB 5:
      INVERSE :
      PRINT "GATE/SPRUE AREA RATIO:";:
      NORMAL :
      PRINT S$;GS:
      VTAB 8:
      INVERSE :
      PRINT "SPRUE HEIGHT ("U1$"):";:
      NORMAL :
      PRINT S$;HS:
      VTAB 11:
      INVERSE :
      PRINT "PATTERN HT. IN COPE ("U1$"):";:
      NORMAL :
      PRINT S$;HC
36800 VTAB 14:
      INVERSE :
      PRINT "PATTERN DEPTH IN DRAG ("U1$"):";:
      NORMAL :
      PRINT S$;HD:
      VTAB 17:
      INVERSE :
      PRINT "TOTAL NUMBER OF GATES:";:
      NORMAL :
      PRINT S$;NG:
      VTAB 20:
      INVERSE :
      PRINT "# GATES ATTACHED TO CASTING:";:
      NORMAL :
      PRINT S$;NA:
      GOTO 37600
36900 VTAB 5:
      Q$ = "GATE/SPRUE AREA RATIO:":
      R = GS:
      GOSUB 1600:
```

```
      IF R <  > GS THEN
         GS = R:
         PRINT X$
37000 VTAB 8:
      Q$ = "SPRUE HEIGHT (" + U1$ + "):":
      R = HS:
      GOSUB 1600:
      IF R <  > HS THEN
         HS = R:
         PRINT X$
37100 VTAB 11:
      Q$ = "PATTERN HT. IN COPE (" + U1$ + "):":
      R = HC:
      GOSUB 1600:
      IF R <  > HC THEN
         HC = R:
         PRINT X$
37200 VTAB 14:
      Q$ = "PATTERN DEPTH IN DRAG (" + U1$ + "):":
      R = HD:
      GOSUB 1600:
      IF R <  > HD THEN
         HD = R:
         PRINT X$
37300 VTAB 17:
      Q$ = "TOTAL NUMBER OF GATES:":
      R = NG:
      GOSUB 1600:
      IF R <  > NG THEN
         NG = R:
         PRINT X$
37400 VTAB 20:
      Q$ = "# GATES ATTACHED TO CASTING:":
      R = NA:
      GOSUB 1600:
      IF R > NG THEN
         HTAB 30:
         PRINT NA;X$;B$;:
         GOTO 37400
37500 IF NA <  > R THEN
         NA = R:
         PRINT X$
37600 GOSUB 2800:
      IF R$ = "Y"GOTO 36900
37700 GOSUB 41600:
      D = HS - .5 * HC * HC / (HC + HD):
      T = PT:
      GOSUB 8600:
      IF U$ = "M" THEN
         F = F * 2.54
37800 IF VN THEN
         GOSUB 41600:
```

```
          GOTO 38900
37900 HOME :
      HTAB 5:
      INVERSE :
      PRINT " SUM OF CASTING SECTIONS ":
      HTAB 5:
      PRINT SPC( 25)"":
      NORMAL :
      I = FRE(0):
      VTAB 10:
      PRINT "HAVE ALL SECTION RISERS BEEN ANALYSED?":
      VTAB 12:
      HTAB 18:
      GOSUB 2900:
      IF R$ <  > "Y"GOTO 38800
38000 VTAB 14:
      PRINT "IS THERE MORE THAN ONE RISER? ";:
      GOSUB 2900:
      IF R$ = "Y"GOTO 38300
38100 IF NOT VC THEN
         GOSUB 4600:
         IF NOT VCGOTO 38800
38200 A = PI * RD * RD / 4:
      B = PI * ND * ND / 4:
      VN = VC:
      SN = SC:
      NC = AC:
      RV = A * (RH - .1 * RD * (RT = 2 OR RT = 5) - TI * (RT = 2)):
      NV = PI * NL * B:
      AN = B:
      WT = TW * (RT = 1 OR RT = 5):
      IA = A * (RT < 5):
      IC = IA * CI:
      L = (RH - TI * (RT = 2)) * (RT < 5):
      SL = L:
      SP = L * CS:
      GOTO 38800
38300 HTAB 1:
      VTAB 10:
      CALL  - 958:
      INVERSE :
      PRINT "PLEASE WAIT WHILE SECTIONS ARE SUMMED:":
      NORMAL :
      PRINT :
      I = 0
38400 F$ = "DATA" + STR$(I) + "/" + LEFT$(PO$,20):
      ONERR GOTO 41400
38410 GOSUB 10400:
      VTAB 12 + I:
      HTAB 10:
      PRINT I
38500 A = PI * ND * ND / 4:
```

```
      B = PI * RD * RD / 4:
      VN = VN + NR * VC:
      SN = SN + NR * SC:
      NC = NC + NR * AC:
      RV = RV + NR * B * (RH - .1 * RD * (RT = 1 OR RT = 5) - TI * (RT = 2)):
      NV = NV + NR * NL * A:
      AN = AN + NR * A
38600 A = NR * DI * TI * B * (RT = 2):
      L = NR * (RH - TI * (RT = 2)) * (RT < 5):
      WT = WT + NR * TW * (RT = 1 OR RT = 5):
      IW = IW + A:
      IC = IC + A * CI:
      SL = SL + L:
      SP = SP + L * CS
38700 I = I + 1:
      IF I < 10GOTO 38400
38750 ONERR GOTO 11600
38800 GOSUB 41600:
      IF NOT VNGOTO 40100
38900 V = VN:
      W = VN * DF:
      IF U$ = "M" THEN
         W = W * 2.2:
         T = PT * 1.8 + 32:
         D = D / 2.54:
         V = VN * 16.4
39000 GOSUB 8700:
      IF U$ = "M" THEN
         GA = GA * 6.45:
         VG = VG * 16.4
39100 AG = GA * NA / NG
39200 VTAB 4:
      PRINT "  WEIGHT OF CASTING  ("U2$"):  ";INT(VN * DF):
      PRINT "  MODULUS OF CASTING ("U1$"):  ";FN P2(VN / SN)
39300 VTAB 8:
      INVERSE :
      PRINT "POURING TIME (SECONDS): ";:
      NORMAL :
      PRINT S$;INT(TP):
      VTAB 11:
      INVERSE :
      PRINT "FLUIDITY OF STEEL ("U1$"): ";:
      NORMAL :
      PRINT S$;FN P1(F)
39400 VTAB 14:
      INVERSE :
      PRINT "NET AREA OF GATES ("U3$"): ";:
      NORMAL :
      PRINT S$;FN P1(GA):
      VTAB 17:
      INVERSE :
      PRINT "WEIGHT OF GATING SYSTEM ("U2$"): ";:
```

```
      NORMAL :
      PRINT S$;INT(VG * DF)
39500 VTAB 20:
      INVERSE :
      PRINT "GATE/CASTING CONNECT AREA ("U3$"):";:
      NORMAL :
      PRINT S$;FN P1(AG):
      GOTO 41000
39600 F = FL:
      IF U$ = "M" THEN
         F = FL / 2.54
39700 GOSUB 8800:
      IF U$ = "M" THEN
         GA = GA * 6.54
39800 AG = GA * NA / NG
39900 VTAB 14:
      INVERSE :
      PRINT "NET AREA OF GATES ("U3$"): ";:
      NORMAL :
      PRINT S$;FN P1(GA);X$;:
      HTAB 29:
      R = GA:
      GOSUB 1700:
      IF GA <  > R THEN
         GA = R:
         PRINT X$
40000 VTAB 8:
      INVERSE :
      PRINT "POURING TIME (SECONDS): ";:
      NORMAL :
      R = TP:
      GOSUB 1700:
      IF R <  > TP THEN
         TP = R:
         PRINT X$
40100 HTAB 1:
      VTAB 11:
      INVERSE :
      PRINT "FLUIDITY OF STEEL ("U1$"): ";:
      NORMAL :
      PRINT S$;FN P1(FL);:
      HTAB 25:
      R = FL:
      GOSUB 1700:
      IF R <  > FL THEN
         FL = R:
         F = FL:
         PRINT X$
40200 IF NOT VNGOTO 40600
40300 IF U$ = "M" THEN
         F = FL / 2.54:
         GOSUB 8800:
```

```
         GA = GA * 6.45:
         GOTO 40500
40400 GOSUB 8800
40500 VTAB 14:
      HTAB 29:
      PRINT FN P1(GA);X$
40600 HTAB 1:
      VTAB 14:
      INVERSE :
      PRINT "NET AREA OF GATES ("U3$"): ";:
      NORMAL :
      R = GA:
      GOSUB 1700:
      IF GA <  > R THEN
         GA = R:
         PRINT X$
40700 HTAB 1:
      VTAB 17:
      INVERSE :
      PRINT "WEIGHT OF GATING SYSTEM ("U2$"): ";:
      NORMAL :
      R = VG:
      GOSUB 1700:
      IF R <  > VG THEN
         VG = R:
         PRINT X$
40800 AG = GA * NA / NG:
      VTAB 20:
      HTAB 36:
      PRINT FN P1(AG);X$
40900 HTAB 1:
      VTAB 20:
      INVERSE :
      PRINT "GATE/CASTING CONNECT AREA ("U3$"):";:
      NORMAL :
      R = AG:
      GOSUB 1700:
      IF R <  > AG THEN
         AG = R:
         PRINT X$
41000 GOSUB 2800:
      IF R$ <  > "Y"GOTO 12700
41100 IF VNGOTO 40000
41200 GOTO 40100
                                          +--+
41300                                     !  !
                                          +--+
41400 CALL 768:
      POP :
      POP :
      GOTO 38700
                                       +-------+
```

```
41500                                   !  SUB  !
                                        +-------+

41600 HOME :
      HTAB 8:
      INVERSE :
      PRINT "  GATING SYSTEM  ":
      HTAB 8:
      PRINT SPC( 17)"":
      NORMAL :
      I = FRE(0):
      VTAB 4:
      RETURN
                              +-------------------------+
41700                         !  *** COST ANALYSIS ***  !
                              +-------------------------+

41800 GOSUB 44400:
      VTAB 5:
      PRINT "  1. ENTER/CHANGE COST DATA":
      VTAB 7:
      PRINT "  2. SHOW COSTS FOR CURRENT RISER":
      VTAB 9:
      PRINT "  3. SHOW CUMULATIVE COST ANALYSIS"
41900 VTAB 11:
      PRINT "  4. TURN PRINTER ";:
      INVERSE :
      PRINT P$:
      NORMAL :
      VTAB 13:
      PRINT "  5. RETURN TO MAIN MENU":
      VTAB 16:
      L% = 5:
      GOSUB 3200
42000 ON R%GOTO 42100,43700,44000,44200,12700
42100 VTAB 19:
      HTAB 1:
      PRINT "GET COST INFO FROM DISK?  ";:
      GOSUB 2900:
      IF R$ <  > "Y"GOTO 42400
42200 C% = 3:
      ONERR GOTO 12200
42300 VTAB 21:
      GOSUB 9000:
      GOSUB 9500:
      GOSUB 9200:
      INPUT CM,CR,CT,CI,CC,CH,CP:
      GOSUB 9400
42400 GOSUB 44400:
      IF CM OR CCGOTO 43200
42500 VTAB 5:
      Q$ = "COST OF MOLTEN METAL    ($/" + U2$ + "):    ":
      R = CM:
      GOSUB 1600:
```

```
      IF R <  > CM THEN
         CM = R:
         PRINT X$
42600 VTAB 7:
      Q$ = "CREDIT FOR SCRAP METAL ($/" + U2$ + "):    ":
      R = CR:
      GOSUB 1600:
      IF R <  > CR THEN
         CR = R:
         PRINT X$
42700 VTAB 11:
      Q$ = "COST OF HOT TOPPING    ($/" + U2$ + "):    ":
      R = CT:
      GOSUB 1600:
      IF R <  > CT THEN
         CT = R:
         PRINT X$
42750 VTAB 13:
      Q$ = "COST OF TOP INSULATION ($/" + U2$ + "):    ":
      R = CI:
      GOSUB 1600:
      IF R <  > CI THEN
         CI = R:
         PRINT X$
42800 VTAB 17:
      Q$ = "RISER/GATE REMOVAL     ($/" + U3$ + "):":
      R = CC:
      GOSUB 1600:
      IF R <  > CC THEN
         CC = R:
         PRINT X$
42900 VTAB 19:
      Q$ = "REMOVAL OF CHILLS      ($/" + U3$ + "):":
      R = CH:
      GOSUB 1600:
      IF R <  > CH THEN
         CH = R:
         PRINT X$
43000 VTAB 21:
      Q$ = "GRINDING OFF PADS      ($/" + U4$ + "):":
      R = CP:
      GOSUB 1600:
      IF R <  > CP THEN
         CP = R:
         PRINT X$
43100 GOTO 43500
43200 VTAB 5:
      INVERSE :
      PRINT "COST OF MOLTEN METAL   ($/"U2$"):    ";:
      NORMAL :
      HTAB 35:
      PRINT FN P3(CM):
```

```
      VTAB 7:
      INVERSE :
      PRINT "CREDIT FOR SCRAP METAL ($/"U2$"):    ";:
      NORMAL :
      HTAB 35:
      PRINT FN P3(CR)
43300 VTAB 11:
      INVERSE :
      PRINT "COST OF HOT TOPPING    ($/"U2$"):    ";:
      NORMAL :
      HTAB 35:
      PRINT FN P3(CT):
      VTAB 13:
      INVERSE :
      PRINT "COST OF TOP INSULATION ($/"U2$"):  ";:
      NORMAL :
      HTAB 35:
      PRINT FN P3(CI)
43350 VTAB 17:
      INVERSE :
      PRINT "RISER/GATE REMOVAL     ($/"U3$"):  ";:
      NORMAL :
      HTAB 35:
      PRINT FN P3(CC)
43400 VTAB 19:
      INVERSE :
      PRINT "REMOVAL OF CHILLS      ($/"U3$"):";:
      NORMAL :
      HTAB 35:
      PRINT FN P3(CH):
      VTAB 21:
      INVERSE :
      PRINT "GRINDING OFF PADS      ($/"U4$"):";:
      NORMAL :
      HTAB 35:
      PRINT FN P3(CP)
43500 GOSUB 2800:
      IF R$ = "Y"GOTO 42500
43600 GOTO 41800
43700 IF NOT RD THEN
         PRINT :
         PRINT B$"   CANNOT DO COST ANALYSIS UNTIL AFTER":
         PRINT :
         HTAB 9:
         FLASH :
         PRINT " RISER SIZE/NECK ":
         NORMAL :
         PRINT :
         PRINT "     OPTION HAS BEEN COMPLETED."B$:
         GOSUB 4000:
         GOTO 41800
43800 A$ = "SECTION  ":
```

```
      V = PI * RD * RD / 4 * (RH - .1 * RD * (RT = 1 OR RT = 5) - TI * (RT = 2)):
      W = PI * NL * ND * ND / 4:
      A = (VC + V + W) * DF:
      B = PI * ND * ND / 4
43900 C = AC:
      D = TW * (RT = 1 OR RT = 5):
      E = DI * TI * PI * RD * RD / 4 * (RT = 2):
      F = E * CI:
      G = (RH - TI * (RT = 2)) * (RT < 5):
      H = G * CS:
      S = (V + W - (SH + MW) * VC / 100) * DF:
      GOSUB 44600:
      GOTO 41800
44000 IF NOT VN THEN
         PRINT :
         PRINT B$"   CANNOT DO CUMULATIVE ANALYSIS UNTIL":
         PRINT :
         HTAB 10:
         FLASH :
         PRINT " GATING SYSTEM ":
         NORMAL :
         PRINT :
         PRINT "     OPTION HAS BEEN COMPLETED."B$:
         GOSUB 4000:
         GOTO 41800
44100 A$ = "CASTING  ":
      A = (VN + RV + NV + VG) * DF:
      B = AN + AG:
      C = NC:
      D = WT:
      E = IW:
      F = IC:
      G = SL:
      H = SP:
      S = (RV + NV + VG - (SH + MW) * VN / 100) * DF:
      GOSUB 44600:
      GOTO 41800
44200 GOSUB 10600:
      GOTO 41800
                                        +---------+
44300                                   !  SUBS   !
                                        +---------+
44400 HOME :
      HTAB 11:
      INVERSE :
      PRINT " COST ANALYSIS ":
      HTAB 11:
      PRINT SPC( 15)"":
      NORMAL :
      I = FRE(0):
      RETURN
                                              +--+
```

```
44500                                          !  !
                                               +--+
44600 HOME :
      INVERSE :
      PRINT "COST ANALYSIS":
      PRINT "--> "A$:
      NORMAL :
      VTAB 1:
      HTAB 16:
      PRINT "BY: ";LEFT$(UN$,21):
      HTAB 15:
      PRINT "FOR: ";LEFT$(CN$,21):
      VTAB 4:
      PRINT "TYPE: ";:
      INVERSE :
      PRINT M$(RT);:
      IF NL THEN
         PRINT "/NECK"
44700 NORMAL :
      PRINT :
      VTAB 5:
      PRINT "MOLDING MATERIAL:";:
      INVERSE :
      PRINT MM$:
      NORMAL
44800 VTAB 8:
      PRINT "MOLTEN METAL:";:
      R$ = STR$(INT(A)) + S$ + U2$ + "    ":
      GOSUB 46100:
      A = A * CM:
      R$ = STR$(FN P1(A)):
      GOSUB 46300
44900 VTAB 10:
      PRINT "R/G CUTOFF:";:
      R$ = STR$(INT(B)) + S$ + U3$:
      GOSUB 46100:
      B = B * CC:
      R$ = STR$(FN P1(B)):
      GOSUB 46300
45000 VTAB 12:
      PRINT "CHILL REMOVAL:":
      IF C = 0 THEN
         GO TO 45200
45100 VTAB 12:
      R$ = STR$(INT(C)) + S$ + U3$:
      GOSUB 46100:
      C = C * CH:
      R$ = STR$(FN P1(C)):
      GOSUB 46300
45200 VTAB 14:
      PRINT "HOT TOPPING:":
      IF D = 0 THEN
```

```
         GO TO 45400
45300 VTAB 14:
      R$ = STR$(INT(D)) + S$ + U2$ + "    ":
      GOSUB 46100:
      D = D * CT:
      R$ = STR$(FN P1(D)):
      GOSUB 46300
45400 VTAB 16:
      PRINT "TOP INSULATION:":
      IF E = 0 THEN
         GO TO 45600
45500 VTAB 16:
      R$ = STR$(INT(E)) + S$ + U2$:
      GOSUB 46100:
      R$ = STR$(FN P1(F)):
      GOSUB 46300
45600 VTAB 18:
      PRINT "RISER SLEEVE:":
      IF G = 0 THEN
         GO TO 45800
45700 VTAB 18:
      R$ = STR$(INT(G)) + S$ + U1$ + "    ":
      GOSUB 46100:
      R$ = STR$(FN P1(H)):
      GOSUB 46300
45800 VTAB 20:
      PRINT "SCRAP CREDIT:";:
      R$ = STR$(INT(S)) + S$ + U2$ + "    ":
      GOSUB 46100:
      S =  - S * CR:
      R$ = STR$(FN P1(S)):
      GOSUB 46300:
      VTAB 21:
      HTAB 33:
      PRINT "========"
45900 VTAB 22:
      INVERSE :
      PRINT DT$;:
      NORMAL :
      HTAB 27:
      PRINT "NET:";:
      R$ = STR$(FN P1(A + B + C + D + F + H + S)):
      GOSUB 46300
46000 GOSUB 4000:
      RETURN
46100 L = LEN(R$):
      IF L < 15 THEN
         R$ = RIGHT$(X$ + R$,15):
         L = 15
46200 INVERSE :
      HTAB 32 - L:
      PRINT R$;:
```

```
      RETURN
46300 L = LEN(R$):
      IF L < 9 THEN
         R$ = RIGHT$(X$ + R$,9):
         L = 9
46400 NORMAL :
      HTAB 41 - L:
      PRINT R$:
      RETURN
                        +-------------------------------------+
46500                   !  *** QUIT/STORE FILES ON DISK ***  !
                        +-------------------------------------+
46600 GOSUB 48400:
      VTAB 5:
      PRINT "   1. SAVE CUSTOMER/CASTING INFO":
      VTAB 8:
      PRINT "   2. SAVE COST INFO":
      VTAB 11:
      PRINT "   3. SAVE SECTION/RISER DATA":
      VTAB 14:
      PRINT "   4. CREATE/ADD TO  SLEEVE FILE":
      VTAB 17:
      PRINT "   5. QUIT PROGRAM"
46700 VTAB 20:
      PRINT "   6. RETURN TO MAIN MENU":
      VTAB 24:
      L% = 6:
      GOSUB 3200:
      ON R%GOTO 46800,47400,47700,48600,11700,12700
46800 A$ = "STORE":
      GOSUB 9800:
      ONERR GOTO 10900
46900 VTAB 13:
      F$ = "INFO/" + LEFT$(PO$,20):
      GOSUB 9300
47000 PRINT UN$;B$;CN$;B$;CA$;B$;CC$;B$;PO$;B$;DT$;B$;CD$;B$;U$;B$;MM$;B$;
47100 PRINT PC;C$;DF;C$;TD;C$;SH;C$;PT;C$;FF;C$;MW;C$;GS;C$;HS;C$;HC;C$;HD;C$;NG;C
      $;NA
47200 GOSUB 9400:
      POKE 216,0:
      GOSUB 48400:
      VTAB 8:
      PRINT "THE CUSTOMER/CASTING INFO FILE:":
      VTAB 10:
      HTAB (34 - LEN(F$)) / 2:
      INVERSE :
      PRINT F$:
      NORMAL :
      VTAB 12:
      HTAB 5:
      PRINT "HAS BEEN SAVED TO DISK.":
      GOSUB 4000:
```

```
      ONERR GOTO 11600
47300 GOTO 46600
47400 GOSUB 48400:
      VTAB 2:
      HTAB 15:
      INVERSE :
      PRINT "COST INFO":
      NORMAL :
      IF NOT CM THEN
         VTAB 10:
         HTAB 7:
         PRINT B$"NO COST DATA TO BE STORED!"B$:
         GOSUB 4000:
         GOTO 46600
47450 ONERR GOTO 11000
47500 VTAB 13:
      GOSUB 9000:
      GOSUB 9300:
      PRINT CM;C$;CR;C$;CT;C$;CI;C$;CC;C$;CH;C$;CP:
      GOSUB 9400:
      ONERR GOTO 11600
47600 GOTO 46600
47700 A$ = "STORE":
      GOSUB 9800:
      ONERR GOTO 11100
47800 GOSUB 48400:
      VTAB 8:
      GOSUB 10100:
      GOSUB 9300
47900 PRINT VC;C$;SC;C$;AC;C$;CN;C$;RT;C$;RH;C$;RD;C$;TW;C$;CS;C$;CI;C$;TI;C$;YD%;
      C$;ND;C$;NL;C$;NR;C$;:
      FOR I = 0 TO 9:
         PRINT VC(I);C$;SC(I);C$;AC(I);C$;CN(I);C$;:
      NEXT I:
      PRINT
48000 GOSUB 9400:
      VTAB 10:
      HTAB 3:
      PRINT "THE SECTION/RISER DATA FILE:":
      VTAB 12:
      HTAB (34 - LEN(F$)) / 2:
      INVERSE :
      PRINT F$:
      NORMAL :
      VTAB 14:
      HTAB 5:
      PRINT "HAS BEEN SAVED TO DISK.":
      GOSUB 4000:
      ONERR GOTO 11600
48100 GOSUB 48400:
      VTAB 10:
      PRINT "DO YOU WANT TO ZERO THE SECTION":
```

```
      PRINT :
      PRINT "VARIABLES AND START A NEW SECTION?":
      PRINT :
      HTAB 18:
      GOSUB 2900:
      IF R$ <  > "Y"GOTO 46600
48200 VC = 0:
      SC = 0:
      AC = 0:
      CN = 0:
      RT = 0:
      RH = 0:
      RD = 0:
      TW = 0:
      CS = 0:
      CI = 0:
      TI = 0:
      YD% = 0:
      ND = 0:
      NL = 0:
      NR = 1:
      N = 0:
      FOR I = 0 TO 9:
         VC(I) = 0:
         SC(I) = 0:
         AC(I) = 0:
         CN(I) = 0:
      NEXT :
      GOTO 46600
                                        +--------+
48300                                   ! SUBS   !
                                        +--------+
48400 HOME :
      HTAB 7:
      INVERSE :
      PRINT " QUIT/STORE FILES ON DISK ":
      HTAB 7:
      PRINT SPC( 26)"":
      NORMAL :
      I = FRE(0):
      RETURN
                              +-------------------------------+
48500                         ! *** SET UP SLEEVE FILE ***    !
                              +-------------------------------+
48600 HOME :
      HTAB 5:
      INVERSE :
      PRINT " RISER SLEEVE DISK FILE ":
      HTAB 5:
      PRINT SPC( 24)"":
      NORMAL :
      I = FRE(0):
```

```
      ONERR GOTO 49700
48700 VTAB 5:
      GOSUB 9000:
      PRINT D$"APPEND "F$:
      ONERR GOTO 11600
48800 A = 0:
      B = 0:
      C = 0
48900 VTAB 8:
      Q$ = "DIAMETER OF THE SLEEVE (" + U1$ + "):":
      R = A:
      GOSUB 1600:
      IF A <  > R THEN
         A = R:
         PRINT X$
49000 VTAB 12:
      Q$ = "COST OF THE SLEEVE ($/" + U1$ + "):  ":
      R = B:
      GOSUB 1600:
      IF B <  > R THEN
         B = R:
         PRINT X$
49100 VTAB 16:
      HTAB 1:
      INVERSE :
      PRINT "APPARENT SURFACE ALTERATION ":
      PRINT "       FACTOR OF THE SLEEVE:";:
      NORMAL :
      R = C:
      GOSUB 1700:
      IF C <  > R THEN
         C = R:
         PRINT X$
49200 GOSUB 2800:
      IF R$ = "Y"GOTO 48900
49300 VTAB 20:
      PRINT D$"WRITE "F$:
      PRINT A;C$;C;C$;B;C$;U$:
      PRINT D$
49400 VTAB 5:
      PRINT "ANY MORE SLEEVES?  ";:
      CALL  - 958:
      GOSUB 2900:
      IF R$ = "Y"GOTO 48800
49500 PRINT :
      GOSUB 9400:
      GOTO 46600

                                          +--+
49600                                     !  !
                                          +--+

49700 IF PEEK(222) <  > 6 THEN
         POKE 216,0:
```

```
         GOTO 11600
49800 PRINT :
      PRINT "FILE NOT FOUND.":
      PRINT "IS THIS A NEW FILE? ";:
      GOSUB 2900:
      IF R$ = "Y" THEN
         PRINT D$"OPEN "F$:
         GOTO 48800
49900 GOTO 48700
```

```
]
J&L: REM LENGTH OF PROGRAM "CANMET"

PROGRAM LENGTH IS 27970 ($6D42) BYTES


J&C: REM SPACE TAKEN UP BY 'REM' STATEMENTS IN "CANMET"

1753 ($06D9) BYTES SAVED

]
J&X: REM VARIABLE CROSS-REFERENCE FOR "CANMET" LINES 10-24300

A      7200, 7300, 7600, 7800, 8000, 8200, 21700, 22400, 23500, 23900
A$     9900, 19300
AC     4700, 5500, 10400
AC(    4700, 5500, 10400
AG     5500
AN     5500, 19500
B      7200, 7300, 7600, 7800, 8000, 8200, 21700, 22400, 23500, 23900
B$     600, 2100, 2500, 3300, 9900, 10200, 11200, 11300, 11400, 11500, 12500, 16500, 2090
0, 21700
C      7300, 7700, 7800, 20600, 20800, 22500
C%     12500, 13600, 19300
CA$    13800, 14600, 14700, 15400
CC     5500
CC$    13800, 14300, 14900, 15500
CD$    13800, 15200, 15900, 16000, 17400
CH     5500
CI     5500, 10400
CM     5700, 24100
CN     4700, 10400
CN$    13800, 14100, 14400, 14500, 15400
CN(    4700, 10400
CP     5300, 21600, 24100
CR     5700
CS     5900, 10400
CT     5700
D      7300, 7700, 7800, 8800, 20800, 22500
D$     3800, 9200, 9300, 9400, 9500, 10600, 10700, 21900, 22600
DF     6100, 13900, 17200, 17500, 24100
DT$    13800, 14100, 15200, 15300, 15500
E      8200, 20800
F      8000, 8600, 8800, 20800
F$     9000, 9200, 9300, 9400, 9500, 10300, 21400, 21500, 23400
FF     7200, 7300, 7600, 7800, 13900, 18100, 18200, 18300, 18400, 22500
FL     8600
G      8000, 8200, 23600, 24000
GA     5500, 8300
GS     8800, 13900
H      8000, 23600
HC     5900, 13900
HD     5900, 13900
HS     5900, 13900
I      300, 2600, 4600, 4700, 4800, 5300, 5500, 12700, 14300, 14500, 14700, 14900, 15100,
 15300, 16000, 19700, 22100, 23000
```

```
IA      19500
IC      19500
IW      5700
K       100
L       1200, 1300, 1800, 1900, 2000, 2100, 4200, 4300, 4400, 5000, 5100, 5300, 5500, 5700
, 5900, 6100, 8200, 10400, 16600, 16700, 21600, 21700, 21900, 23900, 24100
L%      300, 1000, 1300, 1400, 1700, 1900, 2200, 2300, 2600, 3300, 13000, 14200, 14300, 14
400, 14500, 14600, 14700, 14800, 14900, 15000, 15100, 15200, 15300, 15900, 16000, 18000,
 18600, 21200
M       4700, 7700, 7800, 22500, 23700
MC      4600, 4700, 19500
MM$     13800, 17800, 18100, 18200, 18300, 18400, 18700, 18800, 18900, 19000, 22000
MW      13900, 18100, 18200, 18300, 18400, 18700, 18800, 18900, 19000
NA      13900
NC      5500, 19500
ND      5900, 10400
NG      13900
NL      5900, 10400
NR      10400
NV      5300, 19500
P       12700, 21900, 22000
P$      10600, 10700
P%      10600, 21900
P1(     100, 4300, 20100, 20400, 22000, 23500, 23600, 23700, 23900, 24000
P2(     100, 6800, 17200, 17500
P3(     100, 4400, 23900
PC      6600, 6700, 13900, 15800, 17100, 17500, 22000
PI      20800
PO$     9800, 10300, 13800, 15000, 15100, 15500
PT      5000, 5100, 6600, 6700, 13900, 17000, 17500
Q       7200, 7600, 7700, 7800, 8200, 20700, 20800, 22500
Q$      300, 500, 700, 900, 1000, 1400, 1600, 1700, 2600, 13800, 14200, 14300, 14400, 1450
0, 14600, 14700, 14800, 14900, 15000, 15100, 15200, 15300, 15900, 16000, 17100, 20000, 2
0300, 21400, 21500, 23400
R       100, 2400, 2600, 4200, 4300, 4400, 8200, 8700, 10200, 11200, 11300, 11400, 11500,
17000, 17100, 17200, 17300, 20200, 20500, 20700, 21600, 22400, 22500, 24000
R$      600, 700, 1100, 1200, 1300, 1400, 1800, 2000, 2200, 2900, 3300, 3400, 3600, 4000,
10200, 10300, 13500, 15600, 16200, 16300, 16400, 16600, 16700, 16800, 17600, 17800, 1920
0, 21400, 21500, 21600, 22800
R%      3300, 7300, 10900, 11000, 11100, 12000, 12300, 13100, 18000, 18600, 21300, 23600
RD      5900, 10400
RH      5900, 10400
RT      10400
RV      5300, 19500
R$(     1700, 2200, 2600
S       8200, 23900
S$      900, 1700, 15400, 15500, 16100, 17000, 17200, 17300, 17400, 17500, 20900, 23200, 2
3900, 24000, 24100
SC      4700, 5500, 10400
SC(     4600, 4700, 5500, 10400
SH      6600, 6700, 6800, 8200, 13900, 17300, 17500, 20800
SL      5900, 19500
SN      5500, 8700, 19500
SP      19500
T       7200, 7600, 7700, 7800, 8200, 8600, 19900, 20100, 20200, 20600, 20700, 20800, 2090
0, 22400, 22500, 23200, 23700, 24100
```

```
TC     19500
TD     6100, 13900
TI     5900, 10400
TP     8700, 8800
TW     5700, 10400
U$     6600, 13800, 16100, 16600, 16700, 16800, 16900, 17400, 19900
U1$    16900, 20000, 20300, 20900, 21600, 22000, 23200, 23500, 23600, 23700, 23900, 24000
U2$    16900
U3$    16900
U4$    16900, 21600, 24100
U5$    16900, 17000, 17400
U6$    16900, 17200, 17500
UN$    13800, 14100, 14200, 14300, 15400
V      8200, 8800, 24100
VC     4700, 5300, 5500, 10400
VC(    4700, 5300, 10400
VG     5300, 8700
VN     5300, 8700, 19500
W      8200, 8700, 19900, 20400, 20500, 20600, 20700, 20800, 22400, 23200, 24100
WI     5700
WT     5700, 19500
X$     4200, 4300, 4400, 11200, 11400, 11500, 17000, 17100, 17200, 17300, 20200, 20500
YD%    10400
Z      5300, 5500, 5700, 5900, 6100, 19900, 20100, 20200, 20400, 20500, 20900, 21600, 224
00, 22500, 23200, 23500, 23600, 23700, 23900, 24000, 24100
```

```
]
J&X: REM VARIABLE CROSS-REFERENCE FOR "CANMET" LINES 24400-49900

A      25400, 25500, 25600, 26200, 26800, 27700, 28300, 29700, 31920, 32300, 33500, 34300
, 35400, 38200, 38500, 38600, 43800, 44100, 44800, 45900, 48600, 48900, 49300
A$     24900, 25400, 25500, 25600, 26900, 27400, 27800, 28100, 29800, 31920, 31930, 31940
, 32450, 36300, 43800, 44100, 44600, 46800, 47700
AC     29600, 38200, 38500, 43900, 47900, 48200
AC(    29400, 47900, 48200
AG     39100, 39500, 39800, 40800, 40900, 44100
AN     38200, 38500, 44100
B      25000, 25200, 25300, 25400, 25500, 25600, 25800, 27100, 27200, 27300, 27700, 28300
, 29700, 35400, 36100, 38200, 38500, 38600, 43800, 44100, 44900, 45900, 48800, 49000, 49
300
B$     24700, 28700, 32450, 32700, 34000, 34250, 37400, 43700, 44000, 47000, 47400
C      26400, 26800, 27100, 27200, 27300, 27700, 28300, 31200, 31920, 32300, 34300, 34600
, 36100, 43900, 44100, 45000, 45100, 45900, 48800, 49100, 49300
C$     47100, 47500, 47900, 49300
C%     31400, 42200
CA     24800, 26300, 35100
CA$    29000, 47000
CC     42300, 42400, 42800, 43350, 44900, 47500
CC$    29000, 47000
CD$    28900, 47000
CH     42300, 42900, 43400, 45100, 47500
CI     25900, 38200, 38600, 42300, 42750, 43300, 43900, 47500, 47900, 48200
CM     42300, 42400, 42500, 43200, 44800, 47400, 47500
CN     29600, 47900, 48200
CN$    29000, 44600, 47000
CN(    29400, 47900, 48200
CP     42300, 43000, 43400, 47500
CR     42300, 42600, 43200, 45800, 47500
CS     33500, 33600, 33700, 35100, 38200, 38600, 43900, 47900, 48200
CT     42300, 42700, 43300, 45300, 47500
D      31800, 31900, 34500, 34600, 37700, 38900, 43900, 44100, 45200, 45300, 45900
D$     28900, 30300, 31500, 33500, 48700, 49300, 49800
DF     29300, 29500, 29700, 38900, 39200, 39400, 43800, 43900, 44100, 47100
DI     34900, 38600, 43900
DT$    29000, 45900, 47000
E      25400, 25500, 25600, 26100, 26400, 31200, 43900, 44100, 45400, 45500
F      24500, 27700, 28300, 34300, 36100, 37700, 39300, 39600, 40100, 40300, 43900, 44100
, 45500, 45900
F$     24500, 31200, 31300, 31500, 33500, 38400, 46900, 47200, 48000, 48700, 49300, 49800
FF     47100
FL     39600, 40100, 40300
G      27700, 27800, 28300, 29700, 34700, 43900, 44100, 45600, 45700
GA     39000, 39100, 39400, 39700, 39800, 39900, 40300, 40500, 40600, 40800
GS     36600, 36700, 36900, 47100
H      27100, 27200, 27300, 31930, 31940, 32400, 34300, 34700, 34900, 35700, 36100, 43900
, 44100, 45700, 45900
HC     36700, 37100, 37700, 47100
HD     36800, 37200, 37700, 47100
HS     36700, 37000, 37700, 47100
I      24800, 28300, 28400, 29200, 29300, 29400, 33100, 37900, 38300, 38400, 38410, 38700
, 41600, 44400, 47900, 48200, 48400, 48600
IA     38200
```

```
IC    38200, 38600, 44100
IW    38600, 44100
K     24800, 30300, 30950, 31050, 32010, 32020
L     26800, 26900, 27100, 27200, 27300, 27700, 28300, 28900, 31920, 32300, 34000, 34300
, 34500, 34600, 36100, 38200, 38600, 46100, 46200, 46300, 46400
L%    24800, 26700, 41900, 46700
MC    26400, 31200
MM$   29600, 44700, 47000
MW    24500, 29700, 43900, 44100, 47100
M$(   24800, 29600, 30200, 33300, 35400, 44600
N     48200
NA    36800, 37400, 37500, 39100, 39800, 40800, 47100
NC    38200, 38500, 44100
ND    26600, 29950, 30500, 30700, 34900, 38200, 38500, 43800, 47900, 48200
NG    36600, 36800, 37300, 37400, 39100, 39800, 40800, 47100
NL    29950, 30500, 30800, 34900, 38200, 38500, 43800, 44600, 47900, 48200
NR    31050, 38500, 38600, 47900, 48200
NV    38200, 38500, 44100
P$    41900
P%    28900
P1(   27400, 27800, 27900, 28300, 28400, 29700, 29800, 29950, 30100, 30500, 35700, 35900
, 35910, 36200, 36300, 39300, 39400, 39500, 39900, 40100, 40500, 40800, 44800, 44900, 45
100, 45300, 45500, 45700, 45800, 45900
P2(   30000, 39200
P3(   43200, 43300, 43350, 43400
PC    47100
PI    27700, 28300, 34900, 35100, 36100, 38200, 38500, 43800, 43900
PO$   29000, 38400, 46900, 47000
PT    37700, 38900, 47100
Q     28300
Q$    26800, 27100, 27700, 30700, 30800, 36900, 37000, 37100, 37200, 37300, 37400, 42500
, 42600, 42700, 42750, 42800, 42900, 43000, 48900, 49000
R     25800, 25900, 26000, 26200, 26300, 26800, 27100, 27700, 29300, 29400, 29500, 29600
, 30700, 30800, 31050, 31800, 36900, 37000, 37100, 37200, 37300, 37400, 37500, 39900, 40
000, 40100, 40600, 40700, 40900, 42500, 42600, 42700, 42750, 42800, 42900, 43000
      , 48900, 49000, 49100
R$    26100, 26800, 28900, 30900, 31600, 32000, 32010, 32020, 32200, 32400, 33500, 33600
, 33700, 36200, 37600, 37900, 38000, 41000, 42100, 43500, 44800, 44900, 45100, 45300, 45
500, 45700, 45800, 45900, 46100, 46200, 46300, 46400, 48100, 49200, 49400, 49800

R%    24800, 24900, 26700, 29800, 42000, 46700
RD    26600, 26800, 27200, 27400, 27800, 28300, 28700, 29800, 30500, 31900, 31920, 31930
, 31940, 32300, 32400, 32450, 33500, 33600, 33700, 34250, 34300, 34600, 34700, 34900, 35
100, 35700, 36100, 36200, 38200, 38500, 43700, 43800, 43900, 47900, 48200
RH    27100, 27200, 27300, 27400, 27800, 28300, 29800, 34700, 36100, 36300, 38200, 38500
, 38600, 43800, 43900, 47900, 48200
RT    24800, 27200, 27300, 27800, 27900, 28300, 28400, 29600, 30000, 30100, 30200, 33300
, 34700, 34900, 35100, 35400, 35900, 36050, 36100, 36300, 38200, 38500, 38600, 43800, 43
900, 44600, 47900, 48200
RV    38200, 38500, 44100
S     43700, 44200, 45300, 45500
S$    30100, 30400, 35290, 36700, 36800, 39300, 39400, 39500, 39900, 40100, 44800, 44900
, 45100, 45300, 45500, 45700, 45800
SD    29300, 29600, 36100, 38200, 38500, 47900, 48200
SD(   29400, 47900, 48200
SH    24500, 29700, 43900, 44100, 47100
```

```
SL    38200, 38600, 44100
SN    38200, 38500, 39200
SP    38200, 38600, 44100
T     37700, 38900
TD    35100, 47100
TI    26000, 27300, 34700, 34900, 36100, 38200, 38500, 38600, 43800, 43900, 47900, 48200
TP    39300, 40000
TW    27900, 28400, 30100, 35100, 35910, 38200, 38600, 43900, 47900, 48200
U$    33600, 33700, 37700, 38900, 39000, 39600, 39700, 40300, 47000, 49300
U1$   26000, 26800, 27100, 27400, 27800, 28100, 29100, 29800, 29950, 30500, 30700, 30800
, 31800, 36200, 36300, 36700, 36800, 37000, 37100, 37200, 39200, 39300, 40100, 45700, 48
900, 49000
U2$   25900, 29100, 29700, 30000, 30100, 35900, 35910, 36050, 36060, 39200, 39400, 40700
, 42500, 42600, 42700, 42750, 43200, 43300, 44800, 45300, 45500, 45800
U3$   26300, 29100, 39400, 39500, 39900, 40600, 40900, 42800, 42900, 43350, 43400, 44900
, 45100
U4$   29100, 43000, 43400
UN$   29000, 44600, 47000
V     38900, 43800, 43900
VC    24500, 24600, 27700, 28300, 29500, 29600, 29700, 34300, 34900, 36100, 38100, 38200
, 38500, 43800, 43900, 47900, 48200
VC(   29200, 29300, 29400, 47900, 48200
VG    39000, 39400, 40700, 44100
VN    37800, 38200, 38500, 38800, 38900, 39200, 40200, 41100, 44000, 44100
W     38900, 43800, 43900
WI    27900, 28400, 30000, 34900, 35900
WT    38200, 38600, 44100
X$    29000, 29600, 30700, 30800, 36200, 36300, 36900, 37000, 37100, 37200, 37300, 37400
, 37500, 39900, 40000, 40100, 40500, 40600, 40700, 40800, 40900, 42500, 42600, 42700, 42
750, 42800, 42900, 43000, 46100, 46300, 48900, 49000, 49100
YD%   27400, 27800, 28300, 29800, 34900, 36300, 47900, 48200
```

```
                                +--------------------------+
10                              ! ************************ !
15                              ! *                      * !
20                              ! *   CANMET RISERING    * !
25                              ! *                      * !
30                              ! *     SHAPE MENU       * !
35                              ! *                      * !
40                              ! *   BY: M.R. VINER     * !
45                              ! *   20 MARCH  1983     * !
50                              ! *                      * !
55                              ! ************************ !
                                +--------------------------+

100 IF NOT K THEN
        K = 1:
        PRINT D$"BLOAD HGR TEXT":
        POKE 29952,3:
        POKE 29956,0:
        POKE 29958,255
200 GOTO 2300
                                +----------------------+
300                             !  *** SUBROUTINES ***  !
                                +----------------------+

400 HOME :
    VTAB 8:
    PRINT "SHAPE DESCRIPTION FOR:":
    PRINT :
    INVERSE :
    PRINT R$:
    NORMAL :
    PRINT :
    PRINT "IS NOT AVAILABLE."
500 PRINT :
    PRINT :
    PRINT "PLEASE BE PATIENT.    ":
    FOR I = 1 TO 300:
       IF PEEK( - 16384) > 127 THEN
          POKE  - 16368,0:
          RETURN
600 NEXT :
    RETURN
                                          +--+
700                                       !  !
                                          +--+

800 HOME :
    VTAB 10:
    HTAB 12:
    INVERSE :
    PRINT " PLEASE WAIT WHILE ":
    HTAB 12:
    PRINT " PROGRAM IS LOADED ":
    NORMAL :
    RETURN
```

```
                                                +--+
 900                                            !  !
                                                +--+
1000 PRINT D$"BLOAD CHAIN,A520":
     RETURN
                                                +--+
1100                                            !  !
                                                +--+
1200 PRINT "WHICH?  PRESS A NUMBER KEY...  ";
1300 GET R$:
     R% = VAL(R$):
     IF R% < 1 OR R% > L% THEN
        PRINT B$;:
        GOTO 1300
1400 PRINT R$;:
     RETURN
                                                +--+
1500                                            !  !
                                                +--+
1600 VTAB 24:
     HTAB 1:
     PRINT "CHANGE ANY OF THE ABOVE? ";
1700 INVERSE :
     PRINT "Y/N";:
     NORMAL :
     PRINT " ";:
     GET R$:
     IF R$ = "y" THEN
        R$ = "Y"
1800 HTAB 1:
     CALL  - 958:
     RETURN
                                                +--+
1900                                            !  !
                                                +--+
2000 GOSUB 800:
     GOSUB 1000:
     CALL 520"CANMET"
                              +-------------------------+
2100                          !                         !
2200                          !  **** MAIN PROGRAM ****  !
                              +-------------------------+
2300 TEXT :
     HOME :
     INVERSE :
     PRINT "  CASTING WEIGHT/MODULUS: SHAPE MENU  ":
     PRINT SPC( 38):
     NORMAL :
     VTAB 5:
     HTAB 1:
     L = FRE(0)
2400 VTAB 5:
```

```
      PRINT "  1. SET SUB-SECTION NUMBER":
      VTAB 8:
      PRINT "  2. RECTANGULAR PRISM/PYRAMID":
      VTAB 11:
      PRINT "  3. CYLINDER/TORUS/SPHERE":
      VTAB 14:
      PRINT "  4. CONE/TRIANGULAR PRISM":
      VTAB 17:
      PRINT "  5. COMPLEX SHAPE"
 2500 VTAB 20:
      PRINT "  6. RETURN TO MAIN MENU":
      VTAB 24:
      L% = 6:
      GOSUB 1200
 2600 ON R%GOTO 2700,3500,3800,4100,4500,2000
 2700 HOME :
      HTAB 4:
      INVERSE :
      PRINT " CASTING SUB-SECTION NUMBER ":
      HTAB 4:
      PRINT SPC( 28)"":
      NORMAL :
      I = FRE(0):

 2800 VTAB 8:
      PRINT "CURRENT SUB-SECTION # ";:
      INVERSE :
      PRINT S$;N;S$;:
      NORMAL :
      IF NOT N THEN
         PRINT " (MAIN SECTION)"
 2900 VTAB 11:
      HTAB 1:
      PRINT "START A NEW SUB-SECTION? ";:
      GOSUB 1700:
      IF R$ <  > "Y"GOTO 2300
 3000 VTAB 14:
      INVERSE :
      PRINT "NEW SUB-SECTION NUMBER (0-9): ";:
      NORMAL :
      PRINT " ";
 3100 GET R$:
      R = ASC(R$):
      IF R < 48 OR R > 57 THEN
         PRINT B$;:
         GOTO 3100
 3200 R = VAL(R$):
      PRINT R:
      VTAB 17:
      PRINT "ERASE CURRENT VALUES FOR # ";:
      INVERSE :
      PRINT S$;R;S$;:
```

```
      NORMAL :
      PRINT "  ";:
      GOSUB 1700:
      IF R$ <  > "Y"GOTO 2700
 3300 N = R:
      VC(N) = 0:
      SC(N) = 0:
      AC(N) = 0:
      CN(N) = 0:
      VC = 0:
      SC = 0:
      AC = 0:
      NR = 1:
      CN = 0:
      VN = 0:
      SN = 0:
      NC = 0:
      TC = 0:
      RV = 0:
      NV = 0:
      AN = 0:
      WT = 0:
      IW = 0:
      IC = 0:
      SL = 0:
      SP = 0:
      GOTO 2300
                                          +--+
 3400                                     !  !
                                          +--+
 3500 GOSUB 800:
      PRINT D$"BLOAD RECTANGLE.SHP"
 3600 GOSUB 1000:
      CALL 520"RECTANGLES"
                                          +--+
 3700                                     !  !
                                          +--+
 3800 GOSUB 800:
      PRINT D$"BLOAD ANNULUS.SHP"
 3900 GOSUB 1000:
      CALL 520"ANNULUS"
                                          +--+
 4000                                     !  !
                                          +--+
 4100 R$ = " CONE/TRIANGULAR PRISM ":
      GOSUB 400:
      GOTO 2300
 4200 GOSUB 800:
      PRINT D$"BLOAD CONE.SHP"
 4300 GOSUB 1000:
      CALL 520"CONES"
                                          +--+
```

```
4400                                                ! !
                                                    +--+

4500 R$ = " COMPLEX SHAPE  ":
     GOSUB 400:
     GOTO 2300
```

```
]
J&L: REM LENGTH OF PROGRAM "SHAPE MENU"

PROGRAM LENGTH IS 2078 ($081E) BYTES


J&C: REM SPACE TAKEN UP BY 'REM' STATEMENTS IN "SHAPE MENU"

456 ($01C8) BYTES SAVED


J&X: REM VARIABLE CROSS-REFERENCE FOR "SHAPE MENU"

AC     3300
AC(    3300
AN     3300
B$     1300, 3100
CN     3300
CN(    3300
D$     100, 1000, 3500, 3800, 4200
I      500, 2700
IC     3300
IW     3300
K      100
L      2300
L%     1300, 2500
N      2800, 3300
NC     3300
NR     3300
NV     3300
R      3100, 3200, 3300
R$     400, 1300, 1400, 1700, 2900, 3100, 3200, 4100, 4500
R%     1300, 2600
RV     3300
S$     2800, 3200
SC     3300
SC(    3300
SL     3300
SN     3300
SP     3300
TC     3300
VC     3300
VC(    3300
VN     3300
WT     3300
```

```
                          +--------------------------+
 10                       ! ************************ !
 15                       ! *                      * !
 20                       ! *    CANMET RISERING   * !
 25                       ! *                      * !
 30                       ! *  RECTANGULAR SHAPES  * !
 35                       ! *                      * !
 40                       ! *    BY: M.R. VINER    * !
 45                       ! *    18 MARCH  1983    * !
 50                       ! *                      * !
 55                       ! ************************ !
                          +--------------------------+
100 ROT= 0:
    DEF FN P2(A) = INT(A * 100 + .5) / 100:
    GOTO 6500
                            +----------------------+
200                         !  *** SUBROUTINES ***  !
                            +----------------------+
300 A = 0:
    B = 0:
    C = 0:
    D = 0:
    E = 0:
    F = 0:
    G = 0:
    RETURN
400 C% = I / 10000:
    R% = I / 10 - 1000 * C%:
    R = I - 10000 * C% - 10 * R%:
    R$ = CHR$(R + 64):
    IF R = 3 THEN
       R = 29
500 Q$ = CHR$(127) + CHR$(R) + CHR$(127):
    GOSUB 3000:
    RETURN
                                          +--+
600                                       !  !
                                          +--+
700 C% = I / 1000:
    R% = I - 1000 * C%:
    GOSUB 1000:
    HTAB 20:
    PRINT G;X$:
    GOSUB 3000:
    RETURN
                                          +--+
900                                       !  !
                                          +--+
1000 PRINT "LENGTH OF ";:
     INVERSE :
     PRINT R$;:
     NORMAL :
```

```
     PRINT " (";U1$;")?  ";
1100 I = FRE(0):
     L% = 0:
     Q$ = "":
     R$(1) = ""
1200 GET R$:
     L = ASC(R$):
     IF L = 13GOTO 1610
1300 IF L = 8 THEN
        L% = L% - 1:
        IF L% < 0 THEN
           L% = 0:
           GOTO 1200
1400 IF L = 8 THEN
        PRINT R$" "R$;:
        GOTO 1200
1500 IF L < 46 OR L = 47 OR L > 57 OR L% = 10 THEN
        PRINT B$;:
        GOTO 1200
1600 PRINT R$;:
     L% = L% + 1:
     R$(L%) = R$:
     GOTO 1200
1610 IF L%GOTO 1640
1620 IF G THEN
        Q$ = STR$(G):
        RETURN
1630 PRINT B$;:
     GOTO 1200
1640 FOR I = 1 TO L%:
        Q$ = Q$ + R$(I):
     NEXT :
     G = VAL(Q$):
     RETURN
                                          +--+
1700                                      !  !
                                          +--+
1800 PRINT "CHANGE ANY DIMENSIONS? ";
1900 INVERSE :
     PRINT "Y/N";:
     NORMAL :
     PRINT " ";:
     GET R$:
     IF R$ = "y" THEN
        R$ = "Y"
1950 RETURN
                                          +--+
2000                                      !  !
                                          +--+
2100 VTAB 21:
     INVERSE :
     PRINT Q$":";:
```

```
     NORMAL :
     PRINT "  "R$" ("U1$"): ";:
     RETURN
                                                +--+
2200                                            !  !
                                                +--+
2300 HOME :
     VTAB 21:
     GOSUB 2700:
     PRINT "1. SHOW NEXT SHAPE":
     PRINT "2. USE THIS SHAPE":
     PRINT "3. RETURN TO SHAPE MENU":
     PRINT "4. RETURN TO MAIN MENU";:
     HTAB 27:
     INVERSE :
     PRINT "WHICH? ";:
     NORMAL :
     PRINT "  ";:
     L% = 4
2400 GET R$:
     R% = VAL(R$):
     IF R% < 1 OR R% > L% THEN
        PRINT B$;:
        GOTO 2400
2450 IF R% > 2 THEN
        GOTO 6300
2500 PRINT R$;:
     RETURN
                                                +--+
2600                                            !  !
                                                +--+
2700 C% = 146:
     R% = 12:
     IF VC(N) > 0 THEN
        Q$ = "NET VOL. = " + STR$(FN P2(VC(N))) + "    ":
        GOSUB 3000:
        R% = 22:
        Q$ = "NET AREA = " + STR$(FN P2(SC(N))) + "    ":
        GOSUB 3000
2800 RETURN
                                                +--+
2900                                            !  !
                                                +--+
3000 POKE 29953,(C% > 255):
     POKE 29954,C% - (C% > 255) * 256:
     POKE 29955,R%:
     L = LEN(Q$):
     FOR I = 1 TO L:
        R = ASC(MID$(Q$,I,1)):
        POKE 29957,R:
        CALL 30445:
     NEXT :
```

```
      RETURN
                                              +--+
3100                                          !  !
                                              +--+
3200 C% = 1:
     R% = 140:
     Q$ = "VOLUME (" + U4$ + ") = " + STR$(FN P2(V)):
     GOSUB 3000:
     R% = 150:
     Q$ = "SURFACE AREA (" + U3$ + ") = " + STR$(FN P2(S)):
     GOSUB 3000
3300 HOME :
     VTAB 22:
     INVERSE :
     PRINT "A";:
     NORMAL :
     PRINT "DD TO OR ";:
     INVERSE :
     PRINT "S";:
     NORMAL :
     PRINT "UBTRACT FROM SECTION?  ";
3400 GET R$:
     IF R$ <  > "A" AND R$ <  > "a" AND R$ <  > "S" AND R$ <  > "s"GOTO 3400
3500 PRINT R$:
     INPUT "HOW MANY OF THIS SIZE/SHAPE? ";Q$:
     I = VAL(Q$):
     IF R$ = "S" THEN
        VC(N) = VC(N) - V * I:
        RETURN
3600 SC(N) = SC(N) + S * I:
     VC(N) = VC(N) + V * I
3700 PRINT :
     PRINT "ANY NON-COOLING AREAS? ";:
     GOSUB 1900:
     IF R$ = "Y" THEN
        A$ = "NON-COOLING AREA":
        Q = 1:
        GOSUB 4100
3800 HOME :
     VTAB 22:
     INVERSE :
     PRINT "ANY CHILLED AREAS?";:
     NORMAL :
     PRINT " ";:
     GOSUB 1900:
     IF R$ = "Y" THEN
        A$ = "  CHILL AREA":
        Q = 2:
        GOSUB 4100
3900 RETURN
                              +--------------------------+
4000                          !  NON-COOLING/CHILL AREAS  !
```

```
                                +--------------------------+
4100 HGR :
     Q$ = A$:
     C% = 10:
     R% = 0:
     GOSUB 3000:
     Q$ = "================":
     R% = 10:
     GOSUB 3000:
     Q$ = "1. RECTANGULAR":
     C% = 0:
     R% = 30:
     GOSUB 3000:
     DRAW 6AT 110,30:
     Q$ = "2. CIRCULAR":
     R% = 50:
     GOSUB 3000:
     DRAW 7AT 90,50:
     Q$ = "3. ELLIPTICAL"
4200 R% = 70:
     GOSUB 3000:
     DRAW 8AT 100,70:
     Q$ = "4. TRIANGULAR":
     R% = 90:
     GOSUB 3000:
     DRAW 9AT 110,90:
     Q$ = "5. COMPLEX":
     R% = 110:
     GOSUB 3000:
     Q$ = "6. QUIT " + A$ + "S":
     R% = 130:
     GOSUB 3000
4300 HOME :
     GOSUB 2700:
     VTAB 21:
     PRINT "WHICH?  PRESS A NUMBER KEY...";:
     L% = 6:
     GOSUB 2400
4400 HOME :
     GOSUB 300:
     ON R%GOTO 4500,4800,5100,5400,5800,6100
4500 Q$ = "RECTANGLE":
     R$ = "LENGTH":
     GOSUB 2100:
     G = A:
     GOSUB 1100:
     A = G:
     HTAB 26:
     PRINT A"     ":
     HTAB 14:
     PRINT "WIDTH ("U1$"): ";:
     G = B:
```

```
      GOSUB 1100:
      B = G:
      HTAB 26:
      PRINT B"     "
 4600 VTAB 23:
      GOSUB 1800:
      IF R$ = "Y" THEN
         HOME :
         GOTO 4500
 4700 S = A * B:
      VTAB 23:
      GOTO 5900
 4800 Q$ = "CIRCLE":
      R$ = "DIAMETER":
      GOSUB 2100:
      G = A:
      GOSUB 1100:
      A = G:
      HTAB 26:
      PRINT A"     "
 4900 VTAB 23:
      GOSUB 1800:
      IF R$ = "Y" THEN
         HOME :
         GOTO 4800
 5000 S = PI * A:
      VTAB 23:
      GOTO 5900
 5100 Q$ = "ELLIPSE":
      R$ = "LONG AXIS":
      GOSUB 2100:
      G = A:
      GOSUB 1100:
      A = G:
      HTAB 27:
      PRINT A"     ":
      HTAB 10:
      PRINT "SHORT AXIS ("U1$"): ";:
      G = B:
      GOSUB 1100:
      B = G:
      HTAB 27:
      PRINT B"     "
 5200 VTAB 23:
      GOSUB 1800:
      IF R$ = "Y" THEN
         HOME :
         GOTO 5100
 5300 S = PI * A * B / 4:
      VTAB 23:
      GOTO 5900
 5400 Q$ = "TRIANGLE":
```

```
      R$ = " FIRST SIDE":
      GOSUB 2100:
      G = A:
      GOSUB 1100:
      A = G:
      HTAB 29:
      PRINT A"     ":
      HTAB 11:
      PRINT "SECOND SIDE ("U1$"): ";:
      G = B:
      GOSUB 1100:
      B = G:
      HTAB 29:
      PRINT B"     "
 5500 HTAB 12:
      PRINT "THIRD SIDE ("U1$"): ";:
      G = C:
      GOSUB 1100:
      C = G:
      HTAB 29:
      PRINT C"     "
 5600 VTAB 24:
      GOSUB 1200:
      IF R$ = "Y" THEN
         HOME :
         GOTO 5400
 5700 S = A * B * C / 2:
      VTAB 24:
      GOTO 5900
 5800 VTAB 21:
      INVERSE :
      PRINT "COMPLEX SHAPE:":
      NORMAL :
      HTAB 5:
      PRINT "ESTIMATED AREA ("U3$"): ";:
      G = 0:
      GOSUB 1100:
      S = G:
      HTAB 29:
      PRINT S"     "
 5900 HTAB 1:
      INPUT "HOW MANY OF THIS SIZE/SHAPE? ";O$:
      I = VAL(O$):
      IF O = 1 THEN
         SC(N) = SC(N) - I * S:
         GOTO 4300
 6000 IF O = 2 THEN
         SC(N) = SC(N) + I * S:
         AC(N) = AC(N) + I * S:
         CN(N) = CN(N) + I:
         GOTO 4300
 6100 HGR :
```

```
      RETURN
                                              +--+
6200                                          !  !
                                              +--+
6300 TEXT :
      HOME :
      VTAB 10:
      HTAB 12:
      INVERSE :
      PRINT " PLEASE WAIT WHILE ":
      HTAB 12:
      PRINT " PROGRAM IS LOADED ":
      NORMAL :
      IF R% = 3 THEN
         PRINT D$"BLOAD CHAIN,A520":
         CALL 520"SHAPE MENU"
6350 PRINT D$"BLOAD CHAIN,A520":
      CALL 520"CANMET"
                              +--------------------------+
6400                          !  **** MAIN PROGRAM ****  !
                              +--------------------------+
6500 HGR :
      Q$ = "A) RIGHT-ANGLE PRISM":
      C% = 0:
      R% = 0:
      GOSUB 3000:
      DRAW 1AT 170,110:
      GOSUB 2300
6600 ON R%GOTO 7300,6700
6700 GOSUB 300
6800 I = 1380351:
      G = A:
      GOSUB 400:
      HOME :
      VTAB 21:
      I = 166035:
      GOSUB 700:
      A = G
6900 I = 1950902:
      G = B:
      GOSUB 400:
      I = 223090:
      GOSUB 700:
      B = G
7000 I = 2160553.
      G = C:
      GOSUB 400:
      I = 244055:
      GOSUB 700:
      C = G
7100 GOSUB 1800:
      IF R$ = "Y"GOTO 6800
```

```
7200 S = 2 * (A * B + B * C + A * C):
     V = A * B * C:
     GOSUB 3200:
     GOTO 6500
7300 HGR :
     Q$ = "B) TAPERED PRISM":
     C% = 0:
     R% = 0:
     GOSUB 3000:
     DRAW 2AT 180,110:
     GOSUB 2300
7400 ON R%GOTO 8200,7500
7500 GOSUB 300
7600 I = 0640501:
     G = A:
     GOSUB 400:
     I = 064036:
     HOME :
     VTAB 21:
     GOSUB 700:
     A = G
7700 I = 1101152:
     G = B:
     GOSUB 400:
     I = 138115:
     GOSUB 700:
     B = G
7800 I = 0390973:
     G = C:
     GOSUB 400:
     I = 039111:
     GOSUB 700:
     C = G
7900 I = 2150664:
     G = D:
     GOSUB 400:
     I = 243066:
     GOSUB 700:
     D = G
8000 GOSUB 1800:
     IF R$ = "Y"GOTO 7600
8100 S = (A + B) * (C + D) + A * (B + SQR(B^ 2 + (C - D)^ 2)):
     V = A * B * (C + D) / 2:
     GOSUB 3200:
     GOTO 6500
8200 HGR :
     Q$ = "C) TRAPEZOID":
     C% = 0:
     R% = 0:
     GOSUB 3000:
     DRAW 3AT 175,110:
     GOSUB 2300
```

```
8300 ON R%GOTO 9100,8400
8400 GOSUB 300
8500 I = 1120681:
     G = A:
     GOSUB 400:
     I = 140068:
     HOME :
     VTAB 21:
     GOSUB 700:
     A = G
8600 I = 1200432:
     G = B:
     GOSUB 400:
     I = 148043:
     GOSUB 700:
     B = G
8700 I = 1151153:
     G = C:
     GOSUB 400:
     I = 143115:
     GOSUB 700:
     C = G
8800 I = 2100654:
     G = D:
     GOSUB 400:
     I = 238065:
     GOSUB 700:
     D = G
8900 GOSUB 1800:
     IF R$ = "Y"GOTO 8500
9000 S = (A + D) * (B + C) + 2 * D * SQR(A^ 2 + (B - C)^ 2 / 4.):
     V = A * D * (B + C) / 2:
     GOSUB 3200:
     GOTO 6500
9100 HGR :
     Q$ = "D) PYRAMID":
     C% = 0:
     R% = 0:
     GOSUB 3000:
     DRAW 4AT 210,115:
     GOSUB 2300
9200 ON R%GOTO 9900,9300
9300 GOSUB 300
9400 I = 1201201:
     G = A:
     GOSUB 400:
     I = 148120:
     HOME :
     VTAB 21:
     GOSUB 700:
     A = G
9500 I = 2150952:
```

```
      G = B:
      GOSUB 400:
      I = 243095:
      GOSUB 700:
      B = G
 9600 I = 1470803:
      G = C:
      GOSUB 400:
      I = 147090:
      GOSUB 700:
      C = G
 9700 GOSUB 1800:
      IF R$ = "Y"GOTO 9400
 9800 S = A * B + A * SQR(C^ 2 + B^ 2 / 4.) + B * SQR(C^ 2 + A^ 2 / 4.):
      V = A * B * C / 3.:
      GOSUB 3200:
      GOTO 6500
 9900 HGR :
      Q$ = "E) TRUNCATED PYRAMID":
      C% = 0:
      R% = 0:
      GOSUB 3000:
      DRAW 5AT 205,115:
      GOSUB 2300
10000 ON R%GOTO 6500,10100
10100 GOSUB 300
10200 I = 1201201:
      G = A:
      GOSUB 400:
      I = 148120:
      HOME :
      VTAB 21:
      GOSUB 700:
      A = G
10300 I = 2100952:
      G = B:
      GOSUB 400:
      I = 238095:
      GOSUB 700:
      B = G
10400 I = 1300383:
      G = C:
      GOSUB 400:
      I = 158038:
      GOSUB 700:
      C = G
10500 I = 1610554:
      G = D:
      GOSUB 400:
      I = 172055:
      GOSUB 700:
      D = G
```

```
10600 I = 1150855:
      G = E:
      GOSUB 400:
      I = 144085:
      GOSUB 700:
      E = G
10700 GOSUB 1800:
      IF R$ = "Y"GOTO 10200
10800 S = A * B + C * D + (A + C) * SQR(E^ 2 + (B - D)^ 2 / 4.) + (B + D) * SQR(H^ 2
      + (A - C)^ 2 / 4.):
      V = (B * A^ 2 - D * B^ 2) * E / (A - C) / 3.:
      GOSUB 3200:
      GOTO 6500
```

```
]
J&L: REM LENGTH OF PROGRAM "RECTANGLES"

PROGRAM LENGTH IS 5273 ($1499) BYTES


J&C: REM SPACE TAKEN UP BY 'REM' STATEMENTS IN 'RECTANGLES"

460 ($01CC) BYTES SAVED


J&X: REM VARIABLE CROSS-REFERENCE FOR "RECTANGLES"

A      100, 300, 4500, 4700, 4800, 5000, 5100, 5300, 5400, 5700, 6800, 7200, 7600, 8100,
8500, 9000, 9400, 9800, 10200, 10800
A$     3700, 3800, 4100, 4200
AC(    6000
B      300, 4500, 4700, 5100, 5300, 5400, 5700, 6900, 7200, 7700, 8100, 8600, 9000, 9500,
 9800, 10300, 10800
B$     1500, 1630, 2400
C      300, 5500, 5700, 7000, 7200, 7800, 8100, 8700, 9000, 9600, 9800, 10400, 10800
C%     400, 700, 2700, 3000, 3200, 4100, 6500, 7300, 8200, 9100, 9900
CN(    6000
D      300, 7900, 8100, 8800, 9000, 10500, 10800
D$     6300, 6350
E      300, 10600, 10800
F      300
G      300, 700, 1620, 1640, 4500, 4800, 5100, 5400, 5500, 5300, 6800, 6900, 7000, 7600,
7700, 7800, 7900, 8500, 8600, 8700, 8800, 9400, 9500, 9600, 10200, 10300, 10400, 10500,
10600
H      10800
I      400, 700, 1100, 1640, 3000, 3200, 3600, 5700, 6600, 6800, 6900, 7000, 7600, 7700,
7800, 7900, 8500, 8600, 8700, 8800, 9400, 9500, 9600, 10200, 10300, 10400, 10500, 10600
L      1200, 1300, 1400, 1500, 3800
L%     1100, 1300, 1500, 1600, 1620, 1640, 2300, 2400, 2450, 4300
N      2700, 3800, 3800, 5700, 6000
P2(    100, 2700, 3200
P%     5000, 5200
R      3700, 3800, 5000, 6000
R$     300, 1100, 1200, 1400, 1600, 1900, 2100, 2400, 2500, 3400, 3500, 3700, 3800, 4500,
 4800, 4900, 4900, 5100, 5200, 5400, 5600, 7100, 8000, 8700, 9700, 10700
R%     400, 700, 2400, 2450, 2700, 3000, 3200, 4100, 4200, 4400, 6200, 6500, 6600, 7300,
7400, 8200, 8300, 9100, 9200, 9900, 10000
R$(    1100, 1600, 1640
S      2200, 3600, 4700, 5000, 5300, 5700, 5800, 5900, 6000, 7200, 8100, 9000, 9800, 1020
0
SD(    2700, 3600, 5900, 6000
U1$    1000, 2100, 4500, 5100, 5400, 5500
U3$    3200, 5800
U4$    3200
V      3200, 3500, 3600, 7200, 8100, 9000, 9800, 10800
VC(    2700, 3500, 3600
X$     700
```

```
                                +--------------------------+
 10                             ! ************************ !
 15                             ! *                      * !
 20                             ! *    CANMET RISERING   * !
 25                             ! *                      * !
 30                             ! *    ANNULAR SHAPES    * !
 35                             ! *                      * !
 40                             ! *    BY: M.R. VINER    * !
 45                             ! *    20 MARCH  1983    * !
 50                             ! *                      * !
 55                             ! ************************ !
                                +--------------------------+
 90 PRINT "BLOAD HGR TEXT":
    POKE 29952,3:
    POKE 29956,0:
    POKE 29958,255:
    SCALE= 1:
    ROT= 0:
    POKE 232,0:
    POKE 233,64:
    PI = 3.14
100 ROT= 0:
    DEF FN P2(A) = INT(A * 100) / 100:
    GOTO 6500
                                +------------------------+
200                             !  *** SUBROUTINES ***   !
                                +------------------------+
300 A = 0:
    B = 0:
    C = 0:
    D = 0:
    E = 0:
    F = 0:
    G = 0:
    RETURN
400 C% = I / 10000:
    R% = I / 10 - 1000 * C%:
    R = I - 10000 * C% - 10 * R%:
    R$ = CHR$(R + 64):
    IF R = 3 THEN
       R = 29
500 Q$ = CHR$(127) + CHR$(R) + CHR$(127):
    GOSUB 3000:
    RETURN
                                          +---+
600                                       !   !
                                          +---+
700 C% = I / 1000:
    R% = I - 1000 * C%:
    GOSUB 1000:
    HTAB 20:
    PRINT G;X$:
```

```
     GOSUB 3000:
     RETURN
                                                +--+
 900                                            !  !
                                                +--+
1000 PRINT "LENGTH OF ";:
     INVERSE :
     PRINT R$;:
     NORMAL :
     PRINT " (";U1$;")?  ";
1100 I = FRE(0):
     L% = 0:
     0$ = "":
     R$(1) = ""
1200 GET R$:
     L = ASC(R$):
     IF L = 13GOTO 1610
1300 IF L = 8 THEN
        L% = L% - 1:
        IF L% < 0 THEN
           L% = 0:
           GOTO 1200
1400 IF L = 8 THEN
        PRINT R$" "R$;:
        GOTO 1200
1500 IF L < 46 OR L = 47 OR L > 57 OR L% = 10 THEN
        PRINT B$;:
        GOTO 1200
1600 PRINT R$;:
     L% = L% + 1:
     R$(L%) = R$:
     GOTO 1200
1610 IF L%GOTO 1640
1620 IF G THEN
        0$ = STR$(G):
        RETURN
1630 PRINT B$;:
     GOTO 1200
1640 FOR I = 1 TO L%:
        0$ = 0$ + R$(I):
     NEXT :
     G = VAL(0$):
     RETURN
                                                +--+
1700                                            !  !
                                                +--+
1800 PRINT "CHANGE ANY DIMENSIONS? ";
1900 INVERSE :
     PRINT "Y/N";:
     NORMAL :
     PRINT " ";:
     GET R$:
```

```
     IF R$ = "y" THEN
        R$ = "Y"
1950 RETURN
                                          +--+
2000                                      !  !
                                          +--+
2100 VTAB 21:
     INVERSE :
     PRINT Q$":";:
     NORMAL :
     PRINT "  "R$" ("U1$"): ";:
     RETURN
                                          +--+
2200                                      !  !
                                          +--+
2300 HOME :
     VTAB 21:
     GOSUB 2700:
     PRINT "1. SHOW NEXT SHAPE":
     PRINT "2. USE THIS SHAPE":
     PRINT "3. RETURN TO SHAPE MENU":
     PRINT "4. RETURN TO MAIN MENU";:
     HTAB 27:
     INVERSE :
     PRINT "WHICH? ";:
     NORMAL :
     PRINT "  ";:
     L% = 4
2400 GET R$:
     R% = VAL(R$):
     IF R% < 1 OR R% > L% THEN
        PRINT B$;:
        GOTO 2400
2450 IF R% > 2 THEN
        GOTO 6300
2500 PRINT R$;:
     RETURN
                                          +--+
2600                                      !  !
                                          +--+
2700 C% = 146:
     R% = 12:
     IF VC(N) > 0 THEN
        Q$ = "NET VOL. = " + STR$(FN P2(VC(N))) + "    ":
        GOSUB 3000:
        R% = 22:
        Q$ = "NET AREA = " + STR$(FN P2(SC(N))) + "    ":
        GOSUB 3000
2800 RETURN
                                          +--+
2900                                      !  !
                                          +--+
```

```
3000 POKE 29953,(C% > 255):
     POKE 29954,C% - (C% > 255) * 256:
     POKE 29955,R%:
     L = LEN(Q$):
     FOR I = 1 TO L:
        R = ASC(MID$(Q$,I,1)):
        POKE 29957,R:
        CALL 30445:
     NEXT :
     RETURN
                                          +--+
3100                                      !  !
                                          +--+
3200 C% = 1:
     R% = 140:
     Q$ = "VOLUME (" + U4$ + ") = " + STR$(FN P2(V)):
     GOSUB 3000:
     R% = 150:
     Q$ = "SURFACE AREA (" + U3$ + ") = " + STR$(FN P2(S)):
     GOSUB 3000
3300 HOME :
     VTAB 22:
     INVERSE :
     PRINT "A";:
     NORMAL :
     PRINT "DD TO OR ";:
     INVERSE :
     PRINT "S";:
     NORMAL :
     PRINT "UBTRACT FROM SECTION?  ";
3400 GET R$:
     IF R$ <  > "A" AND R$ <  > "a" AND R$ <  > "S" AND R$ <  > "s"GOTO 3400
3500 PRINT R$:
     INPUT "HOW MANY OF THIS SIZE/SHAPE? ";Q$:
     I = VAL(Q$):
     IF R$ = "S" THEN
        VC(N) = VC(N) - V * I:
        RETURN
3600 SC(N) = SC(N) + S * I:
     VC(N) = VC(N) + V * I
3700 PRINT :
     PRINT "ANY NON-COOLING AREAS? ";:
     GOSUB 1900:
     IF R$ = "Y" THEN
        A$ = "NON-COOLING AREA":
        Q = 1:
        GOSUB 4100
3800 HOME :
     VTAB 22:
     INVERSE :
     PRINT "ANY CHILLED AREAS?";:
     NORMAL :
```

```
      PRINT " ";:
      GOSUB 1900:
      IF R$ = "Y" THEN
         A$ = "  CHILL AREA":
         Q = 2:
         GOSUB 4100
3900 RETURN
                              +-----------------------------+
4000                          !  NON-COOLING/CHILL AREAS   !
                              +-----------------------------+
4100 HGR :
      Q$ = A$:
      C% = 10:
      R% = 0:
      GOSUB 3000:
      Q$ = "================":
      R% = 10:
      GOSUB 3000:
      Q$ = "1. RECTANGULAR":
      C% = 0:
      R% = 30:
      GOSUB 3000:
      DRAW 18AT 110,30:
      Q$ = "2. CIRCULAR":
      R% = 50:
      GOSUB 3000:
      DRAW 17AT 90,50:
      Q$ = "3. ELLIPTICAL"
4200 R% = 70:
      GOSUB 3000:
      DRAW 18AT 100,70:
      Q$ = "4. TRIANGULAR":
      R% = 90:
      GOSUB 3000:
      DRAW 19AT 110,90:
      Q$ = "5. COMPLEX":
      R% = 110:
      GOSUB 3000:
      Q$ = "6. QUIT " + A$ + "S":
      R% = 130:
      GOSUB 3000
4300 HOME :
      GOSUB 2700:
      VTAB 21:
      PRINT "WHICH?  PRESS A NUMBER KEY...";:
      L% = 6:
      GOSUB 2400
4400 HOME :
      GOSUB 300:
      ON R%GOTO 4500,4800,5100,5400,5800,6100
4500 Q$ = "RECTANGLE":
      R$ = "LENGTH":
```

```
      GOSUB 2100:
      G = A:
      GOSUB 1100:
      A = G:
      HTAB 26:
      PRINT A"     ":
      HTAB 14:
      PRINT "WIDTH ("U1$"): ";:
      G = B:
      GOSUB 1100:
      B = G:
      HTAB 26:
      PRINT B"     "
4600  VTAB 23:
      GOSUB 1800:
      IF R$ = "Y" THEN
         HOME :
         GOTO 4500
4700  S = A * B:
      VTAB 23:
      GOTO 5900
4800  O$ = "CIRCLE":
      R$ = "DIAMETER":
      GOSUB 2100:
      G = A:
      GOSUB 1100:
      A = G:
      HTAB 26:
      PRINT A"     "
4900  VTAB 23:
      GOSUB 1800:
      IF R$ = "Y" THEN
         HOME :
         GOTO 4800
5000  S = PI * A:
      VTAB 23:
      GOTO 5900
5100  O$ = "ELLIPSE":
      R$ = "LONG AXIS":
      GOSUB 2100:
      G = A:
      GOSUB 1100:
      A = G:
      HTAB 27:
      PRINT A"     ":
      HTAB 10:
      PRINT "SHORT AXIS ("U1$"): ";:
      G = B:
      GOSUB 1100:
      B = G:
      HTAB 27:
      PRINT B"     "
```

```
5200 VTAB 23:
     GOSUB 1800:
     IF R$ = "Y" THEN
        HOME :
        GOTO 5100
5300 S = PI * A * B / 4:
     VTAB 23:
     GOTO 5900
5400 O$ = "TRIANGLE":
     R$ = " FIRST SIDE":
     GOSUB 2100:
     G = A:
     GOSUB 1100:
     A = G:
     HTAB 29:
     PRINT A"     ":
     HTAB 11:
     PRINT "SECOND SIDE ("U1$"): ";:
     G = B:
     GOSUB 1100:
     B = G:
     HTAB 29:
     PRINT B"     "
5500 HTAB 12:
     PRINT "THIRD SIDE ("U1$"): ";:
     G = C:
     GOSUB 1100:
     C = G:
     HTAB 29:
     PRINT C"     "
5600 VTAB 24:
     GOSUB 1800:
     IF R$ = "Y" THEN
        HOME :
        GOTO 5400
5700 S = A * B * C / 2:
     VTAB 24:
     GOTO 5900
5800 VTAB 21:
     INVERSE :
     PRINT "COMPLEX SHAPE:":
     NORMAL :
     HTAB 5:
     PRINT "ESTIMATED AREA ("U2$"): ";:
     G = 0:
     GOSUB 1100:
     S = G:
     HTAB 29:
     PRINT S"     "
5900 HTAB 1:
     INPUT "HOW MANY OF THIS SIZE/SHAPE? ";O$:
     I = VAL(O$):
```

```
     IF Q = 1 THEN
        SC(N) = SC(N) - I * S:
        GOTO 4300
6000 IF Q = 2 THEN
        SC(N) = SC(N) + I * S:
        AC(N) = AC(N) + I * S:
        CN(N) = CN(N) + I:
        GOTO 4300
6100 HGR :
     RETURN
                                          +--+
6200                                      !  !
                                          +--+
6300 TEXT :
     HOME :
     VTAB 10:
     HTAB 12:
     INVERSE :
     PRINT " PLEASE WAIT WHILE ":
     HTAB 12:
     PRINT " PROGRAM IS LOADED ":
     NORMAL :
     IF R% = 3 THEN
        PRINT D$"BLOAD CHAIN,A520":
        CALL 520"SHAPE MENU"
6350 PRINT D$"BLOAD CHAIN,A520":
     CALL 520"CANMET"
                              +-------------------------+
6400                          !  *** MAIN PROGRAM ***   !
                              +-------------------------+
6500 HGR :
     Q$ = "A) (SLICED) CYLINDER":
     C% = 0:
     R% = 0:
     GOSUB 3000:
     DRAW 1AT 170,105:
     GOSUB 2300
7300 ON R%GOTO 8000,7400,6300
7400 GOSUB 300
7500 I = 1000341:
     G = A:
     GOSUB 400:
     I = 128034:
     HOME :
     VTAB 21:
     GOSUB 700:
     A = G
7600 I = 1001102:
     G = B:
     GOSUB 400:
     I = 128110:
     GOSUB 700:
```

```
      B = G
 7700 I = 850733:
      DRAW 2AT 110,105:
      G = C:
      GOSUB 400:
      I = 117073:
      GOSUB 700:
      C = G
 7800 GOSUB 1800:
      IF R$ = "Y"GOTO 7500
 7900 S = PI * C * (A + B + (C + SQR(C * C + (B - A)^ 2)) / 2) / 2:
      V = PI * C * C * (A + B) / 8:
      GOSUB 3200:
      GOTO 6500
 8000 HGR :
      Q$ = "B) ANNULUS":
      C% = 0:
      R% = 0:
      GOSUB 3000:
      DRAW 3AT 170,100:
      GOSUB 2300
 8100 ON R%GOTO 8800,8200,6300
 8200 GOSUB 300
 8300 I = 900241:
      DRAW 4AT 170,74:
      G = A:
      GOSUB 400:
      I = 118024:
      HOME :
      VTAB 21:
      GOSUB 700:
      A = G
 8400 I = 900372:
      DRAW 5AT 138,75:
      G = B:
      GOSUB 400:
      I = 118037:
      GOSUB 700:
      B = G
 8500 I = 1750903:
      G = C:
      GOSUB 400:
      I = 203090:
      GOSUB 700:
      C = G
 8550 I = 901284:
      DRAW 6AT 130,121:
      G = D + .00001:
      GOSUB 400:
      I = 118128:
      GOSUB 700:
      D = G
```

```
8600 GOSUB 1800:
     IF R$ = "Y"GOTO 8300
8700 F = (PI * A - D) / A:
     S = F * (A + B) * (C + (A - B) / 2) + C * (A - B) * (D > 0):
     V = F * C * (A^ 2 - B^ 2) / 4:
     GOSUB 3200:
     GOTO 6500
8800 HGR :
     Q$ = "C) TORUS":
     C% = 0:
     R% = 0:
     GOSUB 3000:
     DRAW 7AT 170,95:
     GOSUB 2300
8900 ON R%GOTO 9600,9000,6300
9000 GOSUB 300
9100 I = 950391:
     DRAW 8AT 161,87:
     G = A:
     GOSUB 400:
     I = 123039:
     HOME :
     VTAB 21:
     GOSUB 700:
     A = G
9200 I = 1521232:
     DRAW 9AT 170,120:
     G = B:
     GOSUB 400:
     I = 152133:
     GOSUB 700:
     B = G
9300 I = 951173:
     DRAW 10AT 134,109:
     G = C + .00001:
     GOSUB 400:
     I = 95127:
     GOSUB 700:
     C = G
9400 GOSUB 1800:
     IF R$ = "Y"GOTO 9100
9500 F = (PI * A - C) / A:
     S = PI * A * B * F + PI * B * B / 2 * (D > 0):
     V = PI * B * B * A * F / 4:
     GOSUB 3200:
     GOTO 6500
9600 HGR :
     Q$ = "D) HEMI-SPHERE":
     C% = 0:
     R% = 0:
     GOSUB 3000:
     DRAW 11AT 170,105:
```

```
      GOSUB 2300
 9700 ON R%GOTO 10200,9800,6300
 9800 GOSUB 300
 9900 I = 1001061:
      DRAW 12AT 165,105:
      G = A:
      GOSUB 400:
      I = 100117:
      HOME :
      VTAB 21:
      GOSUB 700:
      A = G
10000 GOSUB 1800:
      IF R$ = "Y"GOTO 9900
10100 S = PI * A^ 2 / 2:
      V = PI * A^ 3 / 12:
      GOSUB 3200:
      GOTO 6500
10200 HGR :
      Q$ = "E) SECTION OF SPHERE":
      C% = 0:
      R% = 0:
      GOSUB 3000:
      DRAW 13AT 170,100:
      GOSUB 2300
10300 ON R%GOTO 6500,10400,6300
10400 GOSUB 300
10500 I = 780721:
      DRAW 14AT 101,100:
      G = A:
      GOSUB 400:
      I = 107072:
      HOME :
      VTAB 21:
      GOSUB 700:
      A = G
10600 I = 921032:
      DRAW 15AT 167,100:
      G = B:
      GOSUB 400:
      I = 92117:
      GOSUB 700:
      B = G
10700 GOSUB 1800:
      IF R$ = "Y"GOTO 10500
10800 S = PI * (A * A + B * B / 2):
      V = PI * A * (A * A + B * B * 3) / 24:
      GOSUB 3200:
      GOTO 6500
```

```
]
J&L: REM LENGTH OF PROGRAM "ANNULUS"

PROGRAM LENGTH IS 5144 ($1418) BYTES


J&C: REM SPACE TAKEN UP BY 'REM' STATEMENTS IN "ANNULUS"

463 ($01CF) BYTES SAVED


J&X: REM VARIABLE CROSS-REFERENCE FOR "ANNULUS"

A      100, 300, 4500, 4700, 4800, 5000, 5100, 5300, 5400, 5700, 7500, 7900, 8300, 8700,
9100, 9500, 9900, 10100, 10500, 10800
A$     3700, 3800, 4100, 4200
AC(    6000
B      300, 4500, 4700, 5100, 5300, 5400, 5700, 7600, 7900, 8400, 8700, 9200, 9500, 10600
, 10800
B$     1500, 1630, 2400
C      300, 5500, 5700, 7700, 7900, 8500, 8700, 9300, 9500
C%     400, 700, 2700, 3000, 3200, 4100, 6500, 8000, 8800, 9600, 10200
CN(    6000
D      300, 8550, 8700, 9500
D$     6300, 6350
E      300
F      300, 8700, 9500
G      300, 700, 1620, 1640, 4500, 4800, 5100, 5400, 5500, 5800, 7500, 7600, 7700, 8300,
8400, 8500, 8550, 9100, 9200, 9300, 9900, 10500, 10600
I      400, 700, 1100, 1640, 3000, 3500, 3600, 5900, 6000, 7300, 7600, 7700, 8300, 8400,
8500, 8550, 9100, 9200, 9300, 9900, 10500, 10600
L      1200, 1300, 1400, 1500, 3000
L%     1100, 1300, 1500, 1600, 1610, 1640, 2300, 2400, 2450, 4300
N      2700, 3500, 3600, 5900, 6000
P2(    100, 2700, 3200
PI     5000, 5300, 7900, 8700, 9500, 10100, 10800
Q      3700, 3800, 5900, 6000
Q$     500, 1100, 1620, 1640, 2100, 2700, 3000, 3200, 3300, 4100, 4200, 4500, 4800, 5100,
 5400, 5900, 6500, 8000, 8800, 9600, 10200
R      400, 500, 3000
R$     400, 1000, 1200, 1400, 1600, 1900, 2100, 2400, 2500, 3400, 3500, 3700, 3800, 4500,
 4600, 4800, 4900, 5100, 5200, 5400, 5600, 7800, 8600, 9400, 10000, 10700
R%     400, 700, 2400, 2450, 2700, 3000, 3200, 4100, 4200, 4400, 6300, 6500, 7300, 8000,
8100, 8800, 8900, 9600, 9700, 10200, 10300
R$(    1100, 1600, 1640
S      3200, 3600, 4700, 5000, 5300, 5700, 5800, 5900, 6000, 7900, 8700, 9500, 10100, 108
00
SD(    2700, 3600, 5900, 6000
U1$    1000, 2100, 4500, 5100, 5400, 5500
U3$    3200, 5800
U4$    3200
V      3200, 3500, 3600, 7900, 8700, 9500, 10100, 10800
VC(    2700, 3500, 3600
X$     700
```

CANMET RISERING PROGRAMME

USER INSTRUCTIONS

The options of the main menu are as follows:

1. INSTRUCTIONS/TUTORIAL:

   A built-in instruction manual, to be implemented as a future development. As planned, the INSTRUCTIONS program will contain a brief summary of each option in the main menu with a recommended order of selection. This will be followed by a short tutorial on the methodology of risering. Display of the INSTRUCTIONS/TUTORIAL text will be under the control of the user by means of 4 keystroke commands shown at the bottom of the screen.

2. CUSTOMER/CASTING INFO:

   Allows the user to enter his name, the customer name and address, the purchase order #, and the date of the analysis. Casting information consists of a qualitative description of the casting and the pouring temperature, % carbon, density, and shrinkage of the steel.

   The shrinkage of the steel for a given % carbon and pouring temperature is selected by the program, but can be over-ridden by the user. The user can choose to work in imperial or metric units, and to switch units at any time. When changing customer/casting information, press the <RETURN> key at the beginning of the entry field to leave a line unchanged. Typing any characters before <RETURN> will erase the previous entry.

   The molding materials and molding process can be menu-selected by the user (with a default to green silica sand). This choice will affect the feeding distance and mold wall movement allowance for riser size calculations.

   The customer/casting information or section/riser data may be loaded from a disk file (previously generated with Option 8) and may be changed at any time using Option 2.

3. FEEDING DISTANCE:

   Allows the user to estimate the sound feeding distance from the riser for a given casting section, depending on the effective thickness and width of the section, and whether chills or a taper (padding) are used.

   The feeding distances are given from the edge of the riser to an end or to the edge of a drag chill (or to the maximum sound distance for lateral feeding without chill). A preliminary estimate of the riser size is also made for comparison.

Printer output may be obtained here, summarizing all feeding distances for a given section size.

4. CASTING SHAPE/SIZE

A series of options which allow the user to precisely describe the volume and surface area of a casting section to be fed by a single riser. The user can describe the section as a sum of elementary shapes. The shapes are presented using 3-dimensional hi-resolution graphics, and can be used to specify voids within the casting, non-cooling surfaces, and chill areas as well.

Since a riser may feed several sections of differing modulus, the user may label and separately describe sub-sections to be added together in Option 5.

5. RISER SIZE/NECK:

This option cannot be entered until the CASTING SHAPE/SIZE option has been used. If it has, the sub-sections are summed and the maximum modulus is calculated. The user may specify his riser type from a menu of seven choices of cylindrical top risers. If an insulated type is selected, the user will be asked whether to choose a sleeve from stock (via a data file on disk).

Each record on the disk file must contain the inner diameter of the sleeve, the apparent surface alteration factor (ASAF) of the sleeve insulation, the cost per unit length of the sleeve, and an "M" or "I" to indicate whether the numbers in the record are in metric or imperial units.

The program can search the disk file for a particular sleeve diameter (within 5%) or can be set to automatically scan the file for all usable sleeve diameters, showing the riser size analysis for each in turn. A "usable" sleeve is one for which the riser height/diameter is between 0.5 and 2.

If a stock sleeve is not chosen, the user is prompted for the ASAF and cost per unit area of the insulation materials in the sleeve. Then the user must specify any restrictions on height or diameter of the riser in order to obtain the optimum size. If there are no restrictions, the height/diameter ratio may be chosen by the user.

Once a riser is specified, a standard formula riser neck may be calculated by the program and altered by the user as necessary. A detailed summary of the sub-section and riser parameters may be sent to the printer if desired.

6. GATING SYSTEM:

This section is intended to help the user design a gating system for the casting and to provide additional data for a complete cost analysis. The user must type in the ratio of net gate area/sprue area, sprue height, pattern

height and depth, total number of gates, and number of gates attached to the casting. (Some gates may be attached to risers.)

If the net volume and area of the casting have not been summed, the program will ask whether all sections have been risered. If the answer is yes, it will read the appropriate section/riser data files from disk in order to add up the net casting volume and area, the net riser and neck volumes, and other parameters necessary for later cost analysis. Then the program will estimate the required pouring time and the net weight and gate area of the system using a standard formula. These values can be over-ridden by the user.

7. COST ANALYSIS:

The user can enter pertinent cost information, such as cost of molten metal/unit wt, cut-off costs/unit area, etc., or get them from a previously defined disk file.

If Options 4 and 5 have been done, a summary of costs for a given risered section can be printed out. Option 6 is necessary for a net cost analysis. The user can return to Option 5 to change riser type/neck parameters, then re-enter the cost analysis option in order to compare the cost of various possibilities. Comparison can only be made via the printouts.

8. QUIT/STORE FILES ON DISK:

At any time, all customer/casting information (including gating system data), and casting section/riser data can be stored on disk for recall at a later time.

The names of these files are assigned by the program, using the first 20 characters of the purchase order # as part of the file name in order to avoid accidental over-writing of previously stored data from other castings. The cost information entered in Option 7 may also be stored on disk, with a user-selected file name.

A disk file of stock sleeve sizes/costs/insulation factors may be set up or expanded here for use in Option 5 to design the optimum riser for a section.

In this way, the user can interrupt a session as necessary without losing information. This option also tells the user how to immediately re-enter the program without losing data.

9. RECOMMENDED PROCEDURE:

After entering the data required in CUSTOMER/CASTING INFO, the user will normally reduce the casting to a composite of elementary shapes (bars, plates, cylinders, etc.) and will use the FEEDING DISTANCE option to print out a table of possible feeding lengths within each section. For parasitic sections, unless more accurate data is available, the user should assume the

feeding distance will be that of a section fed directly by a riser.

Then the user should check the casting for hot spots, and plan to place a riser or a chill at each of them, noting that placement of a chill will mark a division between separately risered sections. Additional risers will be placed by making use of the feeding distance table already in hand and using block chills, taper chills, or padding as required.

Once the user has decided on the locations of each riser, he should use the CASTING SHAPE/SIZE option to determine the volume, surface area, and chill area for the (sub-) sections to be fed by a given riser. Then the RISER SIZE/NECK option should be used to determine the best riser for the section. A new section and riser may be set up after storing the section/riser data for the section whose analysis is finished. Any section may be re-analyzed by loading its section/riser data file in the CUSTOMER/CASTING INFO option.

The user will normally enter the COST ANALYSIS calculation for each trial riser/neck configuration for a given section in order to find the lowest net cost for an effective risering system for his casting.

In order to obtain a cost analysis for the entire casting, the user must enter the GATING SYSTEM option to sum the risered sections and define the parameters of the gating system for the casting. If the user wants to save his gating system parameters on disk, he must save the customer/casting information after leaving the GATING SYSTEM option.

CANMET RISERING PROGRAMME

SCIENTIFIC BACKGROUND

FEEDING DISTANCE:

Feeding distance calculations are based on the analytical heat flow studies of J.F. Wallace, W.D. Spiegelberg, and R.D. Maier at Case Western Reserve University, as reported in the booklet "Risering Steel Castings," Steel Founders' Society of America, 1973. These are referred to as the SFSA feeding distances.

In the SFSA system, rectangular sections of width W and thickness T (W > T) are called "bars" if W = T and "plates" if W > 2T. The following feeding distance formulae are for "semi-plates" with widths between T and 2T. The same formulae are used for plates, but with the W = 2T substitution.

The feeding distance towards a cooling end face is

$$F_1 = 7.24 \sqrt{W} + 1.51 \sqrt{T} - 5.67$$

The "lateral" feeding distance towards another riser is

$$F_2 = 0.84 \sqrt{W} + 3.38 \sqrt{T} - 2.34$$

The feeding distance towards an end chill is

$$F_3 = 9.14 \sqrt{W} + 4.12 \sqrt{T} - 11.40$$

The feeding distance towards a drag chill - i.e. a chill placed between risers - is

$$F_4 = 10.80 \sqrt{W} - 1.64 \sqrt{T} + 0.88 T - 0.76 W + 0.21 \sqrt{CW} - 7.04$$

The chill thickness is assumed to be 0.6 T, and the maximum width of any drag chill is

$$CW = 2.24 W - 6.02 \sqrt{W} + 2.60 \sqrt{T} + 6.0$$

In the program, F_4 is calculated for the maximum chill width.

A taper may be applied to the upper or lower surface of a casting to produce the thermal gradient necessary to feed any length to soundness. The slope of the taper for a given section size is

$$SL = 0.0648 T - 0.0164 W$$

In this case, T is the thickness of the section before the application of the taper. The taper is not required over a limited distance

near the riser and near the end face of the section. The former distance can be calculated from F_2, while the latter is given by

$$F_5 = 3.16\sqrt{W} + 1.39\sqrt{T} - 3.19$$

It should be noted that the use of a taper to extend the feeding distance can substantially increase the section thickness at the riser. If the taper is to be ground off, this may prove more expensive than the use of chills or additional risers.

RISER SIZE: The modulus method, as described by R.W. Ruddle in The British Foundryman, September 1978, pp. 197-222, was adapted for use in this program:

We assume a cylindrical top riser with a height H, diameter D, and height/diameter ratio g = H/D. If the volume of the casting is V_c, then the liquid demand on the riser will be βV_c, where β is the sum of the shrinkage of the steel and the effective increase in casting cavity size due to mold wall movement upon filling.

In order to properly feed the casting, the riser must have a freezing time longer than that of the casing by some factor δ^2, i.e.

$$t_r = \delta^2 t_c, \qquad (1)$$

where δ is typically about 1.15.
From Chvorinov's Law, the freezing time of the casting is

$$t_c = K^2 (V_c/A_c)^2. \qquad (2)$$

Since the volume of liquid in the riser varies with time, a conservative estimate of the riser freezing time is

$$t_r = \frac{K^2}{f^2} \left(\frac{V_r - \beta V_c}{A_r}\right)^2, \qquad (3)$$

where f is the "modulus extension factor" and takes note of any riser sleeve and topping. This can be expressed as a function of the apparent surface alteration factors (ASAF) of the side (a) and the top (b) of the riser:

$$\frac{1}{f} = \frac{4ga + b}{4g + 1}. \qquad (4)$$

The volume and surface area of the riser are

$$V_r = \pi\, gD^3/4\,, \qquad A_r = \pi D^2(g + 1/4).$$

Substituting into equation (1) and collecting terms gives a cubic equation in the riser diameter D as a function of the riser height/diameter ratio:

$$D^3 - \delta M_c \frac{4ga + b}{g} D^2 - \frac{4\beta V_c}{g\pi} = 0. \qquad (5)$$

This equation is easily solved by successive numerical iteration.

If the riser diameter D is specified, the above equation reduces to a linear equation in riser height H:

$$H = \frac{b\delta M_c D^2 + 4\beta V_c/\pi}{D(D - 4a\delta M_c)}$$

If the riser height H is specified, then equation (5) reduces to a quadratic equation in D with an analytical solution:

$$D^2 - \frac{4a\delta M_c H}{H - b\delta M_c} D - \frac{4\beta V_c}{H - b\delta M_c} = 0$$

If a riser sleeve is used with hot topping, the actual length of the sleeve must be greater than g x D in order to allow for addition of the hot topping. The depth of hot topping is assumed to be one tenth (1/10) of the riser diameter (see C.F. Corbett, British Foundryman 1974, pp. 106-115).

RISER NECK: The riser neck dimensions adopted here are:

Length = riser diameter/2
Diameter = riser diameter/5 + neck length
= .7 x riser diameter

as specified in J.F. Wallace, "Fundamentals of Risering Steel Castings," Steel Founders' Society, 1960.

GATING SYSTEM: The gating system is based on the paper by R.M. Kotschi in "Gating and Risering: State of the Art," Steel Founders' Society, 1982, pp. 51-73.

The pouring time of the gating system as a function of casting weight W in pounds is taken from Lange and Bukowski, "Pouring Times for Steel Castings," U.S. naval Research Laboratory Report, 1958:

$$t_p = (1.733 - 0.267 \ln W)W^{1/2} \text{ seconds}$$

The fluidity of the steel as a function of the pouring temperature T in degrees fahrenheit is taken from Taylor, Rominski and Briggs, Trans AFS, Vol. 49, pp. 1-93, 1941 and from Lillieqvist, Trans AFS, Vol. 58, p. 261, 1950:

$$FL = .07T - 178 \text{ inches}$$

The runner friction factor is set to 0.87. The net area of the sprue base or the runner choke (whichever is the smallest cross-section), according to Kotschi's formulation, is then:

$$A_s = \frac{1.65 \quad V_c}{t_p \; FL \quad P} \text{ square inches}$$

where the pressure head factor P is defined in terms of the sprue height, S, the pattern height in the cope, C, and the pattern depth in the drag, D:

$$P = S - 0.5\, C^2/(C + D)$$

If the gate:runner:sprue area ratios are set to G:R:1, then it follows that the net gate area for the casting is

$$A_G = G\, A_s$$

The net volume of the gating system will be smaller for chunky castings and larger for rangy castings. If we use Ruddle's definition of a ranginess parameter

$$RG = \frac{\text{surface area of casting}}{\text{surface area of cube of volume } V_c} = A_c/6\, V_c^{2/3}$$

then the gating system volume for a typical casting is taken as

$$V_G = 0.05\, V_c \quad (1 + 2.7 \ln RG), \; RG > 1.0$$

$$= 0.05\, V_c, \quad RG < 1.0$$

Since the fluidity of the steel depends or alloy composition and mold material, and the gate area and gating volume depend on the specific gating system design, the user may wish to insert his own formulae into the program.

CANMET RISERING PROGRAMME

METHODOLOGY OF RISERING

1. What is a riser?

   A "vessel" connected by a "neck" to the mold cavity.

2. What is the function of a riser?

   Most metals contract about 2 - 7% upon freezing and, as a result, an unrisered casting will show surface sinks/draws and some internal porosity.

   The function of the riser is to supply feed metal to prevent the formation of surface defects and to limit porosity.

3. How may a proposed riser be shown to be effective?

   Ultimately, the only foolproof test is to make the mold, fill it, let it freeze, and then examine the casting for surface flaws and internal defects.

4. Is it possible to calculate the shape, size, and location of the risers needed for a particular casting?

   For castings of regular section, this may be simply done. However, castings are rarely single simple sections. Usually, they contain "hot-spots" which require special consideration.

5. What is a "hot-spot"?

   A "hot-spot" is any local volume of a casting which freezes appreciably more slowly than the surrounding regions.

6. How can a potential hot-spot be recognized?

   Chunky parts of a casting - those parts with a relatively large volume and a small surface/volume ratio - will remain liquid after thinner, "rangier" sections have frozen. As a result, any inadequacies in the availability or delivery of feed metal will be shown up by the presence of the defects noted in (2) above.

   To help avoid this, risers must be attached to every "primary" hot-spot in addition to being placed at appropriate intervals on the regular sections of the casting.

7. Where are other hot-spots likely to be found?

From (6) above, hot-spots arise wherever the rate of cooling is appreciably reduced. For example, an elbow section loses heat more rapidly from its convex side than from its concave side. As a result, a secondary hot-spot develops in the elbow. Similar problems arise with T-sections.

Hot-spots in both elbows and T-sections may be rendered less severe by rounding off the corners to equalize heat loss.

8. How can secondary hot-spot regions be recognised?

The locations of potential secondary hot-spots may be determined easily using the "inscribed circle" method - the hot-spot will be close to the center of the largest circle that can be inscribed in the drawings of the mold cavity.

9. Is it always necessary to attach a riser to a secondary hot-spot?

Relatively minor hot-spots may be removed by local chilling - placing a metal chill in the surface of the mold cavity closest to the hot-spot. The thickness of the chill should be equal to the section thickness at the area of application.

However, this technique is sometimes ineffective and usually increases molding and stripping costs significantly. In addition, the chilled area must be treated as a chilled end of abutting casting sections.

10. Over what distance will a riser be effective?

This problem has been examined in detail by Wallace and co-workers for the Steel Founders' Society of America, and their recommendations have become known as the SFSA method.

11. On what does feeding distance depend?

It depends on:

1. section size,
2. section shape,
3. section termination, and
4. whether the section is a parasite.

12. How does the feeding distance depend on section size?

For a given shape, the sound feeding distance increases as the section thickness increases.

13. How does feeding distance depend on section shape?

Rectangular casting sections range from "plates" with width/thickness > 2 to "bars" with width/thickness = 1. For a given thickness, a bar has a greater surface/volume ratio, and so it will tend to cool more quickly and feed a shorter distance.

14. Why is section termination important?

If the section is terminated in a chill or an end face, a favourable temperature gradient is established and the feeding distance is greatly increased.

The increase in feeding distance is greatest for an end chill, less so for a chill placed between risers (a drag chill), and least for an end face.

15. What is a parasite section?

A section is deemed to be a parasite when it is attached at one end to a thicker section. In fact, when a thin plate is joined to a thick one along one entire edge, the thick plate may prove to be a very effective riser!

CANMET RISERING PROGRAMME
POSSIBLE FUTURE DEVELOPMENTS

1. EXTENDED SHAPE DESCRIPTION CAPABILITY
   - Additional three-dimensional shapes will be set as necessary, to extend the library of elementary section descriptions.
   - For complex shapes, a menu of possible graphics inputs will be presented (3-D Space Tablet, Graphics Tablet, etc.), and the appropriate user interface developed.

2. ON-LINE INSTRUCTIONS
   - Add an INSTRUCTIONS/TUTORIAL program which can be called up from within the main program at any time to refresh the user's memory about the use of any of the options available. The tutorial text would also be useful as a training aid.

3. KEITH DAVIS METHOD
   - The RISER SIZE/NECK option will be detached as a separate program in order to include graphic output presentation.
   - Sub-sections will be sorted in order of increasing modulus, as required by the numerical method.

4. FEEDING DISTANCE
   - If possible, feeding distance of parasite sections (appendages) will be added to the analysis.
   - Vertical vs horizontal feeding distances will be evaluated and incorporated as necessary.

5. SIDE RISERS
   - Feeding distance and riser size/neck design need to be developed for side risers.

6. REPORT PRINTING
   - Add more detailed cost analysis report via printer output.
   - If possible, a screen dump routine will be installed so that the user can print any displayed screen with a single keypress.

7. GATING SYSTEM DESIGN
   - A more general gating design calculation may be set up, with both top gating and bottom gating designs available.

8. COMPUTER UPGRADE
   - Convert program to run on Apple IIe with 80 columns and upper/lower case prompting and output.
   - Possibly also convert the program to run on the IBM Personal Computer, since it is rapidly gaining popularity with small businesses.